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The Road Issue

BECAUSE the Road Show and the convention of the American Road Builders Association, the major highway convocation of the year, are being held in Chicago next week, this issue of *Engineering News-Record* is devoted mainly to the subject of highways and the regular first-of-the-year review number is scheduled for next week. For those who specialize in road work the contents of this number need not be emphasized, but to the numerous other readers whose direct activities are elsewhere a word of suggestion is pertinent. They will find herein not a complete treatise on the modern road, its design and construction, but a selected list of articles designed to indicate the general development by means of specific example. A résumé of the general trend of highway engineering to date is followed by articles on each kind of road type and practice, together with a series of shorter notes on the minor operations the perfection of which help to make up the technique of road building. No less important, too, are the many pages of advertisements in which the manufacturers of equipment and material set forth their contribution to this important phase of modern engineering. Not all engineers and contractors design and build roads, but they all use them and their construction cost totals about one-tenth of the cost of all construction, so the devotion of one issue of this journal to their description needs no excuse.

The Shenandoah's Last Cruise

A REPORT on the wreck of the navy dirigible "Shenandoah" has finally been rendered by the Naval Court of Inquiry. The findings are mild, almost gentle. In effect they say—we venture to paraphrase the court's lengthy verdict—that the ship was right, that its crew as well as the headquarters officials behaved properly, and that the destruction of the airship by violent storm currents was inevitable. Doubtless all this is true, yet it leaves feelings of dissatisfaction. One gratifying feature of the report is the clearly stated finding that the duralumin framework had been deteriorating by embrittlement, thus confirming what we said in our issue of Nov. 26, when we pointed out the bearing of this fact on future airship construction. As to the court's statement that this deterioration had not weakened the structure there is room for difference of opinion, and the argument on which the court evidently rests its conclusion appears rather dubious from a structural viewpoint. But it is true that at the worst the weakening could only have been of small amount, negligible as a factor in the accident. In its other phases the report is noteworthy in two matters. First, nothing is said of the structural phenomena of the failure. A great structural accident has thus gone by, and not a single ray of light is thrown on the question of what failed, or why or how, except in the over-all statement that the wind forces were so strong as to break the vessel's structure. This is by no means the attitude taken by the engineering profession toward other failures, such as a bridge accident; if any such failure were allowed to go by with no more specific conclusion than that the service stresses exceeded the strength of the bridge it would be considered most unfortunate. Is the case of the "Shenandoah" to profit us no better teaching than that future airships should be built stronger? Second, the findings make no mention of the fact that the weakness of the ship was known from the beginning, and that its destruction in a storm was to be foreseen. We have repeatedly stressed this point in past weeks, not because it is important in placing blame on anyone, but because it divests the ship's destruction in some degree of the aspect of inescapable violence of the elements. These matters now are part of a closed record, however.

Road Salvage

STRENGTHENING and widening paved roads is the great highway problem of the future. Ultimately, in providing public roads, all states will be expending large sums in spreading out the paved zone and in thickening pavement slabs to carry heavier loads. Indeed an approximation to this situation has already been arrived at in a few states having the oldest systems of improved roads. The article in this issue on widening and thickening paved roads in California has, therefore, pronounced value as an example of practice yet in the formative stage. California's case is exceptional in the fact that in its earlier paved road work it put down a large mileage of very thin concrete slab pavement. The thicker pavements of other states will naturally not require strengthening so soon but ultimately the necessity arrives for all roads and there is usually need for widening much sooner than thickening. In all of this work which has been done the fact which stands out is that virtually all of the old road is salvaged. Except where economies arising from changed line or grade overbalance the salvage value of the old pavement, it is rarely torn up. In brief there is very little obsolescence loss in the modern paved road structure. Perhaps it is one of the greatest gains of the pavement widening and strengthening operations now being extended that they are demonstrating this fact.

Simplifying Valuation Work

ANNULMENT of the orders of the Interstate Commerce Commission setting a value on the property of the Los Angeles & Salt Lake R.R., by the U. S. District Court of the Southern District of California, while it may result in the reopening of a number of railroad valuation cases, is quite likely, in the long run, to result in the elimination of many of the features which now complicate all railroad valuation proceedings. These results, of course, will depend upon whether the decision of the District Court is sustained by the Supreme Court. The decision is of such importance that

there is little doubt but that it will be carried to the Supreme Court immediately. Its importance lies not so much in the fact that it has annulled the orders of the Interstate Commerce Commission setting a value upon the property of the railroad in question, but in the fact that the court in doing it said "In no place in any of the statutes bearing upon the question do we find even an implication of any authority on the part of the commission to find that any of the property of any common carrier used in its transportation business has two kinds of value. It is the true actual value of such property, and that only, as we think, that the statutes in question authorize and require the commission to ascertain and fix; and that, it is obvious, it has not done." In saying this the court practically has sustained the contention of the railroad companies of the country, namely, that the commission was endeavoring to establish a "value for rate-making purposes" which differs from, and is usually less than, the true value of the railroads, a value that for simplicity might be called the open-market value of the railroads. If this decision is sustained, much of the work of the commerce commission will be scrapped, but in the end the whole operation of railroad valuation will be greatly simplified.

City Enlargement by Annexation

ENLARGEMENT by annexation of adjacent territory rather than by the slower process of natural growth is an ambition common to American cities. Legislative restrictions generally require a majority popular vote for the project in each political unit concerned. Often if not generally the lesser districts cast a vote less favorable to the annexation project than the larger or mother area, sometimes killing the project. This was forcibly illustrated in an annexation election to determine whether Moline and East Moline, Ill., should be united. Moline voted 12 to 1 for annexation but East Moline vetoed the proposal 3 to 1. Although the relative populations of the two cities in 1920 were as 31 to 9, more people voted on annexation in East Moline than in Moline. The vote was 2,305 for and 183 against in Moline, and 1,967 against and 608 for in East Moline. Doubtless the mass balance of opinion was recorded in each city, which is all that could be hoped for in an election of the kind.

Earth Road Research Undertaken

EARTH roads, which make up 85 per cent of the three million miles of officially-designated public roads, are to be studied to determine what methods of improving surface stability are possible simply by treating or manipulating the roadside soils. This is a task which should have careful deliberation. It is important, therefore, to note that the work is being undertaken by the Highway Research Board as a special study. This has advanced through the preliminaries of a bibliography, a list of patents, a record of current experiment and practice and a count of mileages and expenditures. In brief there has been provided the beginning for planning succeeding procedure, and here is the place for the Highway Research Board to exercise its distinctive function—to plan. It has done so none too often.

There is in all roadbuilding no more complex question into which to launch an investigation than that of stabilizing earth road surfaces. To push out into the welter of conflicting influences of soil, weather, climate, location and drainage without a chart will be to wallow futilely in cross currents. That has been the fate of most previous earth road investigations. It must be avoided in the present investigation by starting with a plan. Obviously there may be many parts to a plan, but two only need be considered for the present purpose.

A plan first must provide definition and specification. In turning over again the pages of an immediately available half-dozen reports and pamphlets on earth road investigations, one finds that definition ranges from native-soil roads through selected-soil, sand-clay, gravel, shell, chats, marl and crushed stone to actual macadam. Again definition ranges from surfacing to foundations and drainage. Design of cross-section and profile is considered and is not. Such are the facts by the book and one's recollection of many articles and reports read, agrees with them. The Highway Research Board has the duty of definition and specification in the new investigation and it should be meticulously performed.

A plan, second, must take cognizance of what has already been determined and published of methods of stabilizing earth road surfaces. Many facts and at least a few definite conclusions can be drawn from the published articles and reports. They are voluminous—of articles alone the Engineering Societies Library has recently compiled a list of 141 of major importance. This testimony analyzed and summarized will help to indicate the ways of further questioning. To epitomize the work done as a preparation for further research is an obvious preliminary but it has often been neglected. One investigation of the Highway Research Board, that into culvert economics, is doing it, and the result is shown in one of the most definitive plans of study now being made into roadbuilding practice. This model is worth study in scheduling the procedure of the earth road studies.

The two examples given are enough to indicate the thought that we feel needs to be driven home to the Highway Research Board. In many of its activities, using voluntary workers and unable to assert control through monetary support, initiative, purpose and driving power have been lacking. In this investigation into earth road economics, the conditions are changed. The technique of research procedure ought to reflect the better conditions. There is no more important research problem, not even the problem of culvert economics, in all roadbuilding than earth road stabilization and any research organization can devote to it its best capacities without inviting criticism. At the same time let us not exaggerate the situation. Earth roads are 85 per cent of all roads in mileage but they carry perhaps less than 15 per cent of the traffic of all roads.

What of Railway Consolidation

FIVE years have passed since the Transportation Act, which was such an important development in railway affairs, provided for consolidating the railways of the country into a limited number of large systems. During the five years this proposed method of simplifying the railway problem has drifted about with no guiding policy, generally becalmed but sometimes blown by political, financial and local interests. Railway consolidation within reasonable limits is justified by economic principles and presents possibilities of considerable advantage. Its practical application, however, is

attended by so many real difficulties and so much opposition, that little progress is being made toward its consummation.

Difficulties which were introduced into the problem from the first by selfish ideas and narrow vision continue unabated and the problem itself has been smothered in disputes over various factors involved and over the intricacies of individual projects of consolidation. Not all opposition is based on selfish motives or narrow vision. There are many real objections and difficulties involved in every project, particularly as to traffic and financial considerations, so that executives responsible for the administration of individual companies are warranted in looking carefully to the direct interests of those who have invested money and hold the securities. But by and large the altogether human desire for self preservation has been governing.

Except for a few cases like the acquisition of the El Paso & Southwestern Ry. by the Southern Pacific System, and the logical acquisition of minor lines by systems to which they are tributary, there have been few real consolidations. The one big consolidation which is active, the major operation planned by the Van Sweringens, is beginning to look too much like the historic but deplorable depredations of the last century, though this one is to be conducted under the ægis of government approval. Some groups of important railroads have come into the ownership of the same financial interests. But as the several roads continue to be operated and financed as distinct units the process is not that of forming a consolidated or single railway systems (as was the case with the British railways), although it might lead to such a consummation.

The law proposing consolidation is evidently not proving effective, and there arises therefore the question: Who is to plan the future consolidated systems? The law says the Interstate Commerce Commission, but the commission has never done this and has not been disposed to accept such a responsibility. In fact, it has now definitely recommended that this provision of the law should be repealed and that consolidations should be left to the initiative of the railways, but subject to approval by the commission. In the present Congress a bill has been introduced to allow the railways three years for such voluntary consolidations, but this is a short period for determining and carrying out a policy involving so many considerations and complications.

Neither alternative is perfect. Consolidations influenced by political motives and academic ideas would hardly result in logical or effective systems, and it is not unlikely that they would be enforced at periods when conditions are unfavorable to the railways and therefore to the real interests of the public. Since the railways concerned, together with other interests involved, would undoubtedly object to many of the proposed compulsory combinations, the result would be a protracted conflict, with large opportunity for the exercise of political and personal influence. With the aid of a map it would not be difficult to partition the country into districts with apparently logical railway systems, either competitive or non-competitive. But even such a process would encounter difficulties in regard to duplications, competition, traffic routes, and the serving of large centers of traffic. In practice, such a simple but arbitrary method is impossible, since there are various rights, conditions and requirements to be recognized legitimately and legally.

On the other hand, if the planning should be left entirely to the railroads and the financial interests controlling them, it would be undertaken naturally from the attitude of benefiting some particular group, rather than from the broader attitude of benefiting the railways as a whole and the country at large. This idea has been evident in some of the consolidations thus far proposed. It might even be carried to the extreme of devising a railway "system" including various desirable points and lines but avoiding others less desirable. Such tendencies would be checked, however, by the government. On the whole, it is better that government regulation should be restricted to the negative or regulatory position.

But regardless of methods, it is pertinent to ask what is really to be gained by consolidation and will the results be worth what they cost. Will the longer lines be strengthened by the smaller ones which they absorb, or will they be weakened by the absorption? And if two or more of the larger lines are consolidated, will the new system be more successful or of greater advantage than its former parts? There is as yet little knowledge or experience upon which to base a reply. Eliminating some of the more highly-paid executives has been suggested as a reduction in expenses, but the amount of such reduction would be negligible in the final accounting. Whether improved operating methods or general transportation service would result, or what the consequent saving would amount to, must be matter for conjecture.

A difficulty which presents serious danger is that of financial results. If a successful line is burdened with weaker additions and suffers in actual loss or in depreciation of the value of its securities, the ill effects will be more widespread than is generally realized. The losses would not be limited to the interests which control the railway, but would be distributed over all the hundreds or thousands of personal or corporate holders of the securities. This point in relation to public welfare appears to be overlooked by those who take up railway consolidation as a political issue.

Two outstanding points may be noted in regard to the consolidation problem. In the first place, no very clear idea has been expressed as to what results are aimed at or expected by a policy of consolidation. Some of the advantages which have been claimed in a general way are problematical or plain guesswork. In the second place, nobody competent to speak from knowledge or authority appears to have stated any definite idea as to how such a policy is to be carried out, especially with regard to its effect upon the interlocking interests of the public and the railways. To forward the progress of consolidation these two points need to be presented and considered in much more definite and conclusive manner than has yet been done.

Railway consolidations are bound to come, though probably not to the extent advocated by some theorists. In order that such procedure may be of final benefit to the country and the people, as well as to the railways, it is highly desirable that more attention should be given to the fundamental features of the problem and to the methods of its application. Furthermore, it is essential that sane and thoughtful study should be given to the general policy, and that each individual project should have thorough consideration as to its practical and economic aspects, apart from speculative or political influences.

The Trends in Highway Development

Observations Based on a Year's Editorial Visits to Highway Departments and Laboratories and on Many Field Studies of Road Construction and Up-Keep Operations

An Editorial Review

HIGHWAY operation is fast becoming an inseparable factor in the problem of road design and construction. This is made evident by the activity of highway officials during a year or two in seeking broader rights-of-way; planning wider roadways and bridges; shortening routes by relocation; bettering alignment and grades; marking, signaling and lighting the trunk roads; keeping main routes clear of snow; and planning grade crossing removal. In almost every detail of road planning, indeed, there is visible in design and construction the growing understanding of operation as the ultimate task of highway development. The advance is a great one in the march of highway thought. And faith has to a remarkable extent been justified by works. The facts are worth presenting.

Route Shortening and Rectification—Old road routes have determined largely the lines on which new roads have been laid down. Freedom of route therefore has been narrowly limited in road location. It rightly must continue to be limited, so far as large liberty to depart from old ways of travel is permissible. There is much opportunity, however, for rectification of alignment and it is being widely grasped. Virtually every state doing much road building can point to scores of fractional relocations and route shortenings made each year to reduce curvature and eliminate stream and railway crossings. This is wholly a move for more efficient operation—there is often no saving in construction cost.

It is repeated that route shortening can be set down as an outstanding policy of road departments everywhere. It is a demand of the motor vehicle so strong that opposition to change is rare even from the land owner who thus has the main road swung away from his door. There are no quantitative records but occasional figures give some measure of what is being accomplished. In Pennsylvania by fractional changes of location and line straightening the driving distances east and west across the state on main traffic routes have been reduced 100 miles. Nearly any state can match this record in character if not in amount.

Right-of-Way and Roadway Widening—With route shortening there has come a spreading out of the highway zone. Roads are being made wider. One state has set a standard for trunk highways of 100 ft. between fences and a 36-ft. roadway—a surfaced strip of 20 ft. and two 8-ft. shoulders. This is Michigan. It has set 30 ft. as the clear width for its bridges. In New Jersey all roads are being paved 20 ft. wide and on hills of 4 per cent grade 5-ft. gutters and curbs are added making 30-ft. pavements. These represent perhaps the maxima in broadened road zones but there is a general move from 18 ft. for two-lane slabs, to 20 ft. The three-lane pavement—27 to 30 ft.—has some recent examples and a number of very forceful advocates but neither practice nor general opinion favors an intermediate width between two-lane and four-lane pavements. For a four-lane pavement the 4-rod right-of-way comes far short of reasonable demands for shoulders and ditches, as well as surfaced roadway. An 80- to 100-ft. zone is needed and is being sought for by highway engineers wherever there is hope of getting it and is being hoped for everywhere else.

The year has recorded notable progress in four-lane highways. In Connecticut some 50 miles of the old Boston Post Road is being paved 36 ft. wide in a right-of-way widened to 80 to 125 ft. and with costly line rectifications. Wayne County, Michigan, has made 40 ft. of concrete its ultimate minimum width and much of the work has been completed or will go under construction next spring. Less definite undertakings are in mind in a score of other localities. The four-lane pavement is no longer a strange thought to highway engineers.

Super-Highways—A sublimation of the growing movement for wider roads is the super-highway—a pestiferous term but one which has come to have definition. A notable example is the 13-mile road under construction from the Wayne County line to Pontiac, Mich. Two 44-ft. parallel pavements separated by a 40-ft. strip for street cars are being built in a 200-ft. right-of-way. Another example is the road that will handle the Hudson River vehicle tunnel traffic through Jersey City over the heights and across the meadows to Newark and Elizabeth. This is a 50-ft. paved road on viaduct and in subway with costly special structures. These are both projects of the immediate present; contemplated highways of the class extend the list considerably. They are obviously a class of highways having a special and isolated purpose but they mark a definite situation in public roads development.

Crossing Elimination—Including these super-highway developments, there has been no greater advance recorded in highway improvement than the year's activities toward railway grade crossing elimination. The approval by the people of New York of a bond issue of $300,000,000 to eliminate railway crossings of state highways at grade and the agreement between Maryland and its three great railways for the removal in ten years share and share alike of all grade crossings on state roads are epochal accomplishments for the improvement of highway operation. They portend much that is hopeful in the very great difficulty of the road and the railway crossing at grade. The ideal of the super-highway involves the separation of intersecting road grades as well as of railway grades, but this accomplishment has been only partially attained in present undertakings.

Pavement Design and Structure—In pavement design there is advance in precision and in pavement structure there is greater finish. There have, indeed, been no radical modifications of prevailing standards since the center joint and thickened slab edge were developed from the Bates Road tests and other contemporaneous investigations. This section exhibits increased use but there are a number of variations in joint design and in the manner of securing the thicker edge and there

are a number of highway departments which deny the superior merits of the newer section and are continuing the old section. All states, however, show more precise designing and more finished structure.

In surface finish, standards generally are being raised. This is true of bituminous types as well as of concrete and is likewise true of brick. In the most recent brick roads the concrete base is floated to a crown and surface as perfect as a concrete pavement and the cushion is struck off to ensure even thickness. There is a growing trend in brick road construction toward 3-in. and 2½-in. brick but the desirability of the thinner surfacing is by no means generally conceded. In asphalt surfacing there is a pronounced drift toward stiffer mixtures (less bitumen and more filler) and toward better compaction. In all types the improvement in finish is coming from more exacting work and not from any new procedure.

Without any very definite proof to offer there is a rather firm conviction of a swing toward a greater use of steel in concrete roads both as edge bars, dowels and joint plates and as true structural reinforcement. There are more engineers too who are conceding the desirability of frequent transverse expansion joints. Both movements are particularly interesting in the light of the survey made of the economics of reinforcement of concrete roads by the Highway Research Board results of which are given on p. 11. The conclusions of this survey are that cracking is luced by reinforcement and that the cracks do not open as widely. It brought out too a surprising regularity of transverse crack spacing.

Construction Plant and Methods—Like road design and structure, road construction exhibits surprisingly little that is new in plant or methods. Experimental methods and outfits have gone out. One scarcely sees a central mixing plant and wet batch haulage. Standard manufactured road building equipment is rarely varied from, and individual ingenuity is devoted to securing efficiency in its operation and not to invention of special outfits. As a result road work on the average is more orderly and effective in all its procedures. To use a sporting term, "form" is being developed. If observation is indicative and if studies made by the Bureau of Public Roads are not entirely misleading there is, however, far to go in developing efficiency.

Plant and methods are improving but what attracts the attention more sharply is the better co-ordination between construction departments and contractors. A great deal more than formerly is being done by the departments to inform contractors of local materials and transportation conditions; to allot, distribute and plan contracts so as not to congest requirements for rail delivery and labor and not to carry operations over the winter; to lay out work promptly, give quick decisions on subjects in question and to hasten estimates. Highway departments are developing better contractual relations using the broad meaning of the term.

Widening and Resurfacing—As a construction task the revamping of old paved roads has mounted to importance. Wherever states have paved roads dating back a decade there are some roads which have become too narrow, or not strong enough for, or have weakened under, the present intensity and weight of traffic and they must be widened and thickened. This work this year has occupied more attention than ever before. In all of it the great point of interest is that the old surfacing is being salvaged almost in its entirety. If one fact of greatest economic importance can be said to have developed in the year, it is that little of our older paved roads need be thrown away when time brings the necessity for wider and stronger roads.

Maintenance and Marking—More miles of roads have been placed under systematic maintenance and the upkeep is more intensive than ever before. The patrol system predominates, with special gangs for exceptional or supplemental work. Maintenance expenditures are increasing and the quality of maintenance is better. An increasing mileage—the total is now over 25,000 miles—is being kept clear of snow for winter travel. Dust palliation is more general on soil roads. Indeed the increased consideration in maintenance which the earth road is receiving everywhere is an outstanding feature of modern road practice.

With maintenance increasing, state road departments have been thrown into big business operations. They are clearly not all equally capable in their new task—indeed some have failed rather signally—but many have created an organization and plant and are directing and accounting their operations by methods creditable to the best business practice. There is a highway development here, which is perhaps least considered of all by the general public and even by engineers, that is not surpassed in magnitude and importance in all the activities of public road administration.

There are noticed noteworthy advances in marking roads and not much which is commendable in signaling. There are now few main line highways whose direction and caution marking is not reasonably complete and does not show plan and purpose. Signaling generally shows confusion of mind in almost every respect of principle and practice. The highway engineer is yet a tyro in the practice of signaling and lighting the highways. There is need for training and research.

Research Developments—There has been culmination of research service in two outstanding investigations during the year. The Board of Highway Research has concluded its studies of the economy of reinforcing for concrete roads and the Bureau of Public Roads has completed construction-economic studies of road grading and concrete paving. Both are accomplishments of high practical value to the road engineer and contractor. Besides these principal studies, research activity is represented by perhaps a hundred problems being investigated by the Bureau of Public Roads, state highway departments, and institutional laboratories. There is altogether a looking up of research activity manifest among the agencies available for road research.

Federal Activity and Influence—No summary of the highway situation in the United States would be complete without recognition of the work of the Bureau of Public Roads. Appreciation of the Bureau's influence in uplifting sound practices and curbing extravagances of all kinds comes to one with every contact he makes with highway management by the states. It is a mighty co-ordinator of the 48 great road-improvement agencies of the country and of the highway practices in which there is spent yearly a billion dollars.

Widening and Thickening California Paved Roads

General Methods and Costs Given and Specific Operations Described—Improvement of Grade, Alignment, and Drainage Often Included—Plant and Procedure

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General Methods and Costs

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THE reconstruction of already improved highways, since the enactment of special revenue measures in 1923, has in California assumed a position of high importance. By legislative action in 1923, the revenue available for maintenance and widening was doubled in amount and a gas tax was substituted for the former horsepower registration fee. The total revenue is divided equally with the counties of the state, and is now raised by a 2c. gas tax and a nominal registration fee. In 1924 the state highway department received about $9,000,000 as its share from these sources. The law requires that this be expended for maintenance, repairs, widening and reconstruction of state highways. About 60 per cent is annually available for major widening and reconstruction.

Several plans are followed in the widening and reconstruction of pavements. The structure to be used on a specific project is chosen after a study of the physical features. Availability of materials, condition and width of the existing pavement, alignment, grades and soil conditions enter into the choice of type. The present and probable future traffic are considered in planning the width.

Most of the original pavements built by the state are of portland cement concrete, 15 ft. wide and from 4 to 5 in. thick. Many miles of county-built pavements of varying types and widths, generally of light construction, have been incorporated into the state's system. Widening includes concrete shoulders built flush with the existing pavement; raised concrete shoulders and asphalt concrete surfacing; asphalt concrete shoulders and surfacing for the full width, and second story concrete shoulders and resurfacing. In locations of light traffic and where suitable materials are available, oiled macadam shoulders are sometimes built. Fig. 1 shows typical methods of widening and thickening employed in the specific projects described in the following article.

The original width of pavement constructed from five to fifteen years ago was 15 ft. This width becomes overstressed with a traffic in excess of 1,000 vehicles per day. Corner breaks and settlement of the edges occur, and it is impossible to keep shoulders flush with the pavement. Our traffic counts indicate that a 20-ft. pavement readily handles a traffic up to 6,000 vehicles per day, and is not overstressed until 10,000 vehicles per day is reached. When the traffic exceeds that amount, additional widening or a second road is considered necessary. Often, however, this heavier traffic occurs in suburban districts where the building of a full width street, with curbs and gutters, is required, and a large portion of the cost is defrayed by the adjacent property owners. The width generally adopted for the average pavement reconstruction is 20 ft.

Where the existing pavement is in good condition, cement concrete shoulders 2½ ft. wide and 7 in. thick are placed at either side of the existing 15-ft. slab. In preparing sub-base for this type of widening, the soil is excavated for several inches beneath the edge of the existing pavement to form a joint and give added strength to the edge of the old pavement. Most work of this nature contemplates future surfacing over the entire width of the pavement. It is usually required that only one side of the highway be worked on at a time in order that there may be no interruption to traffic. During 1924 California completed about 26 miles of this type of widening at an average cost of $10,493 per mile. This also included the widening of grade from 21 ft. or 24 ft. to 30 ft. and the extension of culverts.

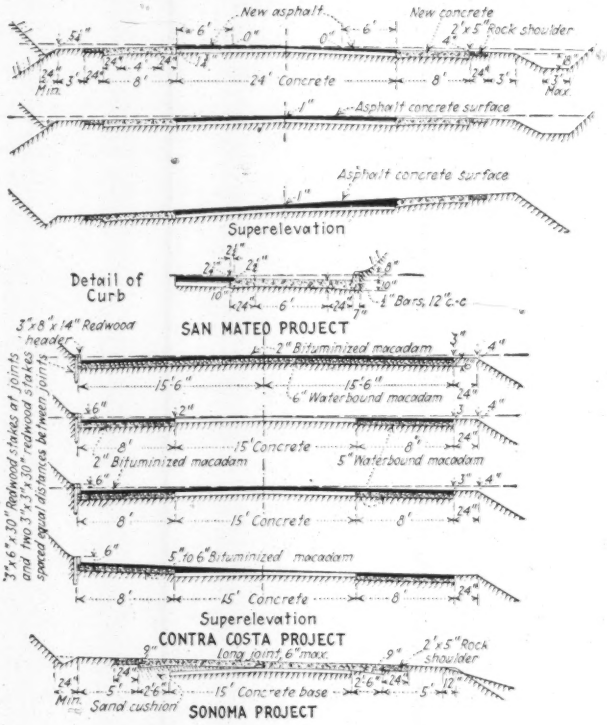

FIG. 1—REPRESENTATIVE CROSS-SECTIONS FOR WIDENING AND THICKENING

These sections are all from the three actual widening operations described and include all but the concrete "Second Story" construction shown separately in Fig. 2. They show clearly how details vary while still holding to certain base-type standards.

A type of widening and thickening which has proven very successful is a combination of concrete shoulders and asphalt concrete wearing surface. The shoulder is laid 7 or 8 in. thick at either side of the existing concrete slab and raised about 3 in. above it. An asphalt surface not less than 2 in. thick is placed over the old pavement and extends into an offset built into the new

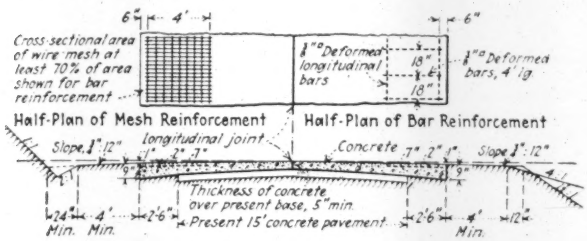

FIG. 2—SECOND STORY WIDENING AND THICKENING

concrete shoulder, thus making a perfect seal and watertight joint. This type of surfacing and widening is placed where the existing concrete base is still in fairly good condition but where it may be predicted that the end of its economic life is fast approaching. About 180 miles of concrete highways have been widened and thickened by this method at an average cost of $22,400 per mile.

A variation is the construction of asphalt shoulders instead of concrete shoulders. A base 2½ ft. wide and 4 to 5 in. thick of asphaltic concrete is placed at the side. This is followed by a leveling course of asphalt, and a wearing surface completes the job. The cost on a typical project, which includes rather heavy grading quantities and the lengthening of many drainage structures, was approximately $30,000 per mile. For the paving alone, the cost is usually little less than the cost of building concrete shoulders and asphalt center.

This plan has been successfully used on widening oiled macadam highways. The first step usually consists in placing a macadam foundation at the side of the existing oiled macadam highway and permitting it to remain open to traffic over a season. This is followed by the placing of a leveling course over the old pavement and the new shoulders, which is followed with a wearing surface of the same material. One typical project of this nature in 1924 cost about $24,000 per mile for an 8½-mile section.

Oiled macadam roads have been widened, thickened and leveled with asphalt concrete in varying widths. The thickness of the new surfacing usually varies from 1½ in. to 3 in. The aim of such work is to improve riding qualities of the surface and utilize the old base as a foundation. Such work will average $10,000 per mile in cost.

The most costly type of reconstruction is "second story" concrete. This consists of a slab of concrete usually 20 ft. in width placed on and over-lapping the edges of the original 15-ft. pavement. For this work the standard thickness is a minimum of 5 in. in the center, increasing to 7 in. at the edge of the old slab and 9 in. at the outside edge. Special attention is paid to the sub-base under the overlapping edge of the new pavement, and the extensions beyond the edge of the old pavement are reinforced with steel. Transverse and longitudinal joints are placed. This type of resurfacing is usually chosen where the old pavement is broken and in poor condition, having reached the end of its economic life. About 78 miles of this type of reconstruction have already been installed at an average cost of about $31,720 per mile, including widening the grade and lengthening drainage structures.

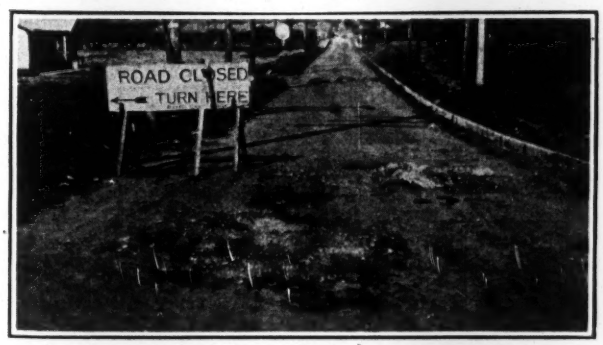

FIG. 3—TYPICAL BROKEN-UP CONDITION DEMANDING RESURFACING

This is one of the original 15-ft. 4-in. concrete pavements.

California has widened state highways to widths of 20, 24, 27, 30, 40 and 56 ft. On one particular job a 24-ft. asphalt surface on a concrete base was widened to 40 ft. by means of 8-ft. concrete shoulders on both sides, 8 in. in thickness with 10-in. edges. The old asphalt center was dressed up with a new asphalt concrete wearing surface. On this width of highway separated into traffic lanes by the appearance of the materials, the slow moving commercial traffic tends to concentrate on the shoulders at the side, leaving the center free for faster traffic.

* * *

Construction Methods and Plant

By N. A. Bowers
Associate Editor, *Engineering News-Record*, San Francisco Calif.

THERE is no standard practice in widening state highways in California because each job or even different parts of the same job may require very different treatments. A considerable mileage of pavement on the state system has been widened by simply adding concrete shoulders, raised a few inches above the old pavement, and filling in over the old pavement with new material. This scheme can be and is used in some portions of almost every widening job but the policy of the present commission is to lay out each widening project so that the greatest possible improvement can be obtained for the expenditure even though this necessitates abandoning parts of the old paving. Very frequently, as an adjunct to widening the road, sharp vertical curves are flattened out, slight changes in alignment are made and curves are superelevated even where this requires partial or complete removal of the old pavement.

In order to care for traffic on roads under construction where detours would be long or inadequate the work is done in halves, the traffic being carried on one side of the center line while work is done on the other. It is customary not to work on such jobs on Saturday afternoons, Sundays and holidays because of the interference resulting from the traffic. To keep materials clean and avoid waste the commission does not permit the use of stock piles along the road; either a central mixing plant is used or sand and gravel are brought in in batches which are dumped from the trucks directly into the mixer skip.

In some locations it is advisable to put all of the increased width on one side of the center line such as beside buildings or railroads where the clearance is already limited. Even out in the open it may be economy to shift the increased width to one side to avoid the necessity of extending large culverts on both ends.

Where adequate funds are available certain refinements or superior methods are used which cannot be included where the money available is sufficient for bare

necessities only. For example, headers for rock shoulders are recognized as highly desirable to prevent sloughing before the rock bases are placed, because the sloughing weakens the edge by making it thinner, but where strict economy is necessary, especially if the subgrade is hard, they are omitted. Where funds permit, headers are put in first and then shoulder material is graded up against them on the outside. Another refinement is the use of redwood curbs with tile drains immediately back of and below curbs in through cuts, where right-of-way width does not permit open ditches. Where it can also be afforded, a 3x8-in. plank is staked in place for a curb above finished surface grade and gravel is filled in behind to extend by this step the porous fill over the tile.

Old concrete pavement that is removed is usually broken up by hand to "one-man" sizes and piled along the right-of-way. When this accumulates in any considerable quantity it has been found worth-while to bring out a portable rock crusher and work it up for shoulder material.

Occasionally, where it is planned to put a "second

FIG. 4—COMPLETED CONCRETE RESURFACING AND WIDENING

This is a concrete road similar to that shown in Fig. 3 after "second story" as in Fig. 2, has been completed.

story" on pavement already nearing the point of breaking up under traffic, it has been decided that if materials for the job were to be hauled over half of such a pavement while the other half was being reconstructed this hauling would practically destroy what was left of the old pavement. Light railways are usually required in such cases for the delivery of materials. In one such case recently the contractors were offered, and the successful bidder adopted, the alternative of using pneumatic tires on trucks for delivering materials.

Where new pavement is laid, say in two 10-ft. strips, over the old roadway it is sometimes found desirable to use two concrete finishing machines, one following the other. Otherwise, a single machine may have so much work to do that the mixing crew has to wait in order to avoid getting too far ahead of the finisher. With two finishing machines the surplus concrete piled up ahead of the following machine is picked up by the machine ahead and moved along toward the mixer. The use of the two machines has been found to give a very satisfactory finish but the transverse and longitudinal floating with a 2-man float is continued nevertheless. The edges of each slab are then tooled up by hand and the surface is ready for the burlap which is put on as soon as this can be done without marking the concrete. Standard curing processes are used.

Three typical widening and reconstruction jobs on the

FIG. 5—PLACING ASPHALT SHOULDER ON CONCRETE ROAD

Shoulders are flush with old concrete and widen road to 20 ft. Full 20-ft. width is then surfaced with asphaltic concrete.

California state system were recently visited in company with engineers in charge: (1) The peninsula highway in San Mateo County, where the work in the main is pouring concrete shoulders on either side of the present pavement and filling the channel between with asphaltic concrete; (2) the Sonoma County job, which is wholly a "second-story" project; and (3) the work in Contra Costa County, involving much regrading with incidental reconstruction of the old pavement, the increased width being made with a quarry waste base topped with bituminous macadam, with probable future increase in thickness through "second-story" work.

The San Mateo Project—Work on the peninsula highway consists of adding two 8-ft. concrete shoulders to a 24-ft. concrete pavement, bringing these shoulders up above the old pavement and filling up to the new grade with asphaltic concrete. The new shoulders are 8 in. thick in the center with both edges thickened to 10 in. Under certain conditions in heavy cuts, as noted in the following, the width is increased to 10 ft. and a curb is put on top of the pavement.

On this job the contract requires that one side of the new work be finished and opened to traffic before the other side is begun. The first step was grading and rolling down the shoulder under the outer header board, 8 ft. from the edges of the old pavement. Going

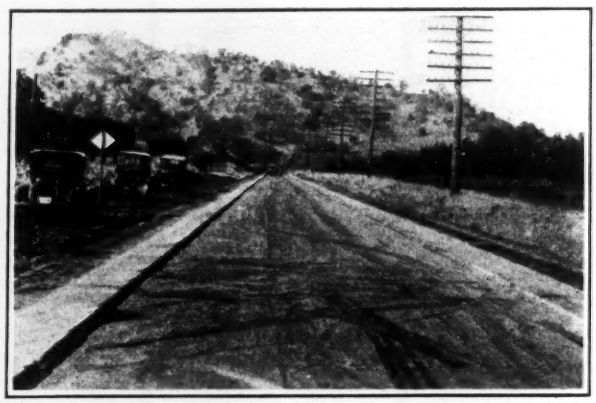

FIG. 6—CONCRETE SHOULDERS WIDENING OLD CONCRETE ROAD

These shoulders are placed so as to form a curb for the asphaltic concrete with which old pavement is resurfaced.

over the line two to four times with a 12-ton three-wheel roller sufficiently compacted the subgrade, the amount of compression varying from a fraction of an

inch in sand to 3 or 4 in. in loam. For headers 3x12-in. planks are used, set on top of grade stakes, 4 ft. apart. Between the grade stakes and also 4 ft. apart, stakes are driven outside the headers and nailed to them to support them in an upright position.

The state establishes grade a foot or two out from the header, this grade being the tops of 3x6-in. stakes, driven every 25 ft. on vertical and horizontal curves and elsewhere 50 ft. apart. The contractor gets the line by measuring 8 ft. out from the edge of the old pavement which is, in the process of excavating for the new shoulder, scraped clean of old header boards, etc. The line for the inside face of the new shoulder headers is then marked by a cord stretched between ½x1½ strap-iron stakes driven into the subgrade.

The excavation for the shoulders is made to within 2 in. of the required depth, the ground is then lightly scarified and thoroughly rolled. In dry weather it is necessary to sprinkle to get the subgrade as compact as possible. Ordinarily four or five trips with the roller are sufficient. The rule is that the desirable moisture content in the subgrade is that which will give a uniform consistency of the material when thoroughly scarified and rolled. Unless scarifying is done in connection with this sprinkling and rolling the subgrade has been found to develop hard spots which cause cracks.

After this rolling the shaping of the subgrade for the deeper edges of the new concrete is done with a subgrader. This scrapes the surplus material into two windrows which are later taken off by square-nosed shovels. The subgrader is drawn behind the roller and 2 to 4 trips are necessary, according to the amount of material to be removed.

The subgrade is then ready for testing. This is done with a templet moved along the header boards to make sure that the grade is not too low and with a spike templet whose spikes extend down to within ½ in. of the prescribed subgrade level, to show that it is not too high.

The top of the outer header already mentioned marks the grade to which the concrete is to be finished along that edge. Along the edge of the old pavement the state establishes grade marks at a certain distance below the finished grade and the contractor uses these in shimming up a 2x8-in. header laid on it flat, overhanging the edge of the old pavement 2½ in. This overhanging portion is supported on 2x2-in. stakes driven into the subgrade on 4-ft. centers. These stakes are left in the concrete but it is to be noted that they are covered by the asphaltic concrete put in after the headers are removed and hence do not afford a means whereby water may later get under the slab. The overhanging header breaks the joint that would otherwise go straight through to subgrade between old pavement and new shoulder. The concrete is poured up to the level determined by the top of the two headers and is struck off with finishing machines in the usual manner.

The state has a 66-ft. right-of-way along this route. Wherever the alignment is such that there is not room for standard ditches between the widened pavement and the bank of a cut, the 8-ft. additional width has been increased to 10 ft. 7 in., terminating in a curb 7 in. thick, and the ditch has been omitted entirely. These curbs, of course, then become the toe of the cut slope.

FIG. 7—SPREADING ASPHALTIC CONCRETE RESURFACING

This road was widened as shown in Fig. 5. Note the use of stone and gravel spreader for spreading the asphaltic mixture.

FIG. 8—PLACING HEADERS OR SIDE FORMS FOR "SECOND STORY" PAVING

This is the type of reconstruction shown by Fig. 2 as employed on the San Mateo project. Observe some of the details as given in the text.

FIG. 9—TWO FINISHERS USED ON CONCRETE RESURFACING

With a thin surfacing slab to be built the paver is held up by the finishing where one machine alone is used.

In building these curbs the pavement beneath them is first finished off in the same manner as the remainder of the job. After the finishing machines have been taken off, ½-in. corrugated bars 15 in. long are thrust 8 in. into the concrete to serve as dowels for holding the curb. Two planks are then placed to serve as curb forms. They are held apart by spreaders placed every 4 ft. at both top and bottom of the planks which are clamped tight by 1-in. iron rods, whose tops, shaped like an inverted L, draw the two planks together as the rods are driven drown into the subgrade. No endeavor is made to bond the curbs into the slab concrete and hence in case further widening should later be decided upon, it will only be necessary to break up the curb and cut off the dowels, no resurfacing being required.

On some jobs the drain tile is laid back of these inverted curbs and the trench filled with gravel to the top of the curb. This has not always been satisfactory for the reason that after a few years, if the adjoining formation carries an abundance of "fines" this material washes down through the gravel and clogs the drain. On the peninsula highway the space back of the curb is simply filled with earth, all drainage being taken care of on the surface of the pavement in cuts. Cuts are protected by diversion trenches.

Outside the concrete shoulders being added to this highway, 2-ft. rock shoulders, 5 in. thick, are being placed. The thickness of the asphaltic concrete over the old pavement ranges from 1 in. at the center to about 2¾ in. at the edge where there is no superelevation. In superelevated sections the thickness ranges up to a maximum of about 10 in. at the edge. Here no attempt is made to save asphalt by the use of a sand cushion on the old pavement, the desired thickness of asphalt being obtained by thoroughly rolling it in 2-in. layers.

The peninsula-widening job extends over a length of 4.4 miles of highway for which the total cost was $210,000, or about $48,000 per mile.

The Sonoma County Project—Widening and reconstruction of a 4-in., 15-ft. concrete pavement placed in 1913 between Healdsburg and Mark West in Sonoma County was necessary because the old pavement was too thin and too narrow for the traffic it was carrying. In this case a "second-story" concrete pavement was selected because of the heavy trucking using the route.

This job is being done in two ways: (1) Where the traffic is being maintained on half the pavement the new pavement is being put down in two 10-ft. strips; (2) where it has been possible to detour the traffic the entire roadway has been closed and the concreting has been done as a single pour 20 ft. wide. In either case the minimum thickness is 5 in. at the center increased to 9 in. at edges with wire mesh reinforcing 4 ft. wide along the edges.

The first step in the operation as carried on on this job was to drill holes 4 ft. apart in the old pavement marking the center line of the new roadway. The shoulders were then graded, rolled and scraped to the required section. Where half of the pavement width was to be placed at a time, 2-in. longitudinal headers were placed along the center line, held in place by staples thrust into the holes in the old pavement. Where the work was done full width with detoured traffic, ½-in. strips were used similarly held by staples and were left in the pavement, slightly below the finished surface so an asphalt filler could be used to cover them.

FIG. 10—CURING CONCRETE SHOULDERS, SAN MATEO PROJECT

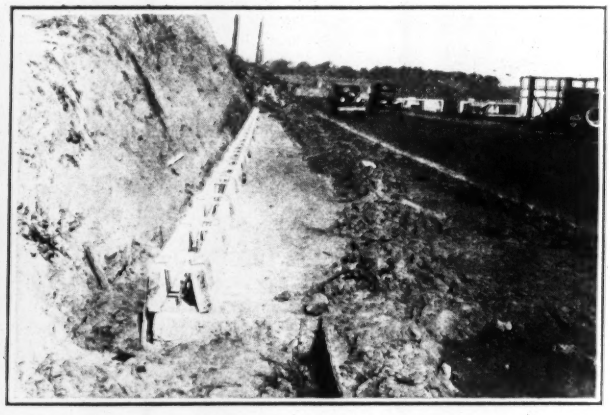

FIG. 11—CURB FORMS, SAN MATEO PROJECT

Transverse expansion joints were placed every 100 ft. and were formed by headers set down ¼ to ½ in. below the finished surface. These headers were made slightly wedge-shaped to facilitate removal and were taken out on the second day after pouring. An important point in connection with transverse headers on "second-story" work is the necessity for fitting them closely to the irregularities of the old pavement. If these irregularities were spanned by a header that did not fit, concrete would get under the header and transmit enough thrust from slab to slab so that expansion would cause buckling at the joints. Each header therefore was carefully fitted to the exact location where it was to be used, the work being done by a carpenter.

When new paving was put down in two 10-ft. strips it was formerly the practice of the California Commission to stagger the joints so as to avoid making four

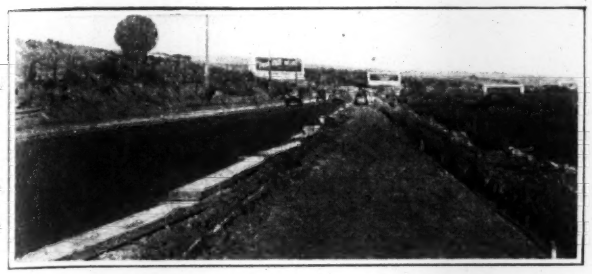

FIG. 12—ROLLING SUBGRADE FOR CONCRETE SHOULDERS

corners together on the center line where two would otherwise suffice. This plan, however, has been discontinued because a crack usually extended from the joint in one slab across the other slab anyway.

On the Sonoma job the old rock shoulders were in fairly good shape due to long continued compacting under traffic and on superelevated sections a sand cushion was graded up on the old shoulder and spread over the old pavement almost to the center to avoid the necessity for making the new concrete slab more than 6 in. thick. Mesh reinforcement was used along the edges throughout the entire job.

This project involved a total length of 8.8 miles of reconstructed pavement 20 ft. wide, for which the total cost was about $32,000 per mile, including culverts.

The Contra Costa Project—The reconstruction in Contra Costa County between San Pablo and El Ciervo called for extensive grading work necessitated by increasing the radii of both horizontal and vertical curves in the hilly district traversed, and also by the increase in paved width from 15 to 31 ft. Seven feet might have sufficed on this project but an 8-ft. shoulder is the minimum width on which it is believed economical to operate a roller, and final decision was for this extra width.

No concrete was laid on this job. Where the original 4-in. concrete pavement was still in good condition no increased thickness was put on; where a new wearing surface was needed a 2-in. bituminized macadam was put over the concrete and where the old pavement was completely taken out for grade changes or where it had begun to disintegrate or crack badly the new work was a 2-in. bituminized macadam on a 6-in. waterbound macadam base.

The right-of-way was first graded up to a 40-ft. width and adequate open ditches were provided where this could be done without excessive grading. In deep cuts the additional cutting back of the banks to provide for ditches was not held justifiable and 4-in. tile drains were accordingly put in in gravel-filled trenches. The trenches were 12 in. deep below the pavement surface and above the pavement a 6-in. redwood plank retained an additional gravel fill of this depth.

In sections where the old concrete was left undisturbed and without additional thickness, the shoulders were graded and rolled to a depth that would allow for a 5-in. waterbound base and a 2-in. bituminized macadam surface finished off to the grade of the existing concrete. Two-foot rolled earth shoulders were used on fills.

Notable vertical curvature improvement was made on the road. In a vertical curve at Oleum, for example, the radius was increased from 300 to 800 ft. The grading necessary to get down to this longer radius was done by cutting down the two sides of the roadway alternately, thus allowing the traffic to use one side or the other at all times.

This project affected 6.6 miles of roadway and besides the paving itself included modifications of drainage structures and 38,000 cu.yd. of grading. The total cost was $150,000, or an average of about $23,000 a mile.

Economic Value of Reinforcement in Concrete Roads

POSITIVE conclusions of importance are considered possible from the survey of plain and reinforced-concrete roads made in 1925 by the Highway Research Board. In the survey of some 3,000 miles of road, data on original structure and construction and on present condition are tabulated and charted and comparisons made. The survey was made by C. A. Hogentogler, Highway Research Board, and the text, tabulations and charts make a considerable volume. The conclusions are:

1. The amount of cracking and subsequent disintegrating is a function of time; thus, the rate of cracking is a measure of the life of the pavement.

2. The data show that steel reinforcement reduced the rate of cracking and thus increased the life of the pavement. This applies both to concrete pavements and other pavements laid upon a concrete base.

3. Crack reduction is more economically accomplished by the use of steel reinforcement than by additional thickness of concrete.

4. A greater reduction was afforded by small steel members closely spaced than by larger members wider spaced.

5. Increasing weight of mesh from 25 to 56 lb. per 100 sq.ft. considerably reduced cracking.

6. Mesh reinforcement, 25 to 56 lb. per 100 sq.ft., reduced cracks 35 to 70 per cent in pavements of like thickness.

7. Mesh reinforcement, 25 to 56 lb. per 100 sq.ft. and bar mat reinforcement 65 lb. per 100 sq.ft—25 per cent longitudinal—reduced cracks more than one additional inch of concrete, but one additional inch of concrete reduced cracks more than bars (42 to 48 lb. per 100 sq.ft.) placed transversely only.

8. With good crushed stone aggregate, 56 lb. per 100 sq.ft. mesh reinforcement, or 170 lb. per 100 sq.ft. bar reinforcement, 50 per cent each way, caused a reduction in combined transverse and longitudinal cracks equal to that indicated for 2 in. additional center thickness.

9. Mesh reinforcement of 38 lb. per 100 sq.ft. has been effective for a thin layer of concrete laid as resurfacing upon an old concrete road.

10. One additional inch of edge thickness reduced corner cracks more than mesh reinforcement 25 to 56 lb. per 100 sq.ft., of $\frac{3}{8}$ to $\frac{3}{4}$ in. bar reinforcement, but progressive destruction following the appearance of corner cracks is arrested by steel reinforcement.

11. All types of steel reinforcement across cracks tended to hold together fractured slabs.

12. Bar reinforcement across transverse joints, without proper provision for slippage and clearance, resulted in breakage and subsequent expensive repairs.

13. For long slabs, 75 to 100 ft. or over, edge bar reinforcement with continuous bond caused corner cracks if the area of steel exceeded $\frac{1}{4}$ sq.in.

14. A remarkable agreement was found to exist between results of observations on roads in service and results furnished by a wide range of experimental roads and laboratory tests.

Failure of Dam in Wales Due to Washout Under Foundation

Concrete Footings Not Carried to Depth Required by Plans—Poor Concrete—Lack of Engineering Supervision

AN OLD concrete dam in the hills about three miles from the town of Dolgarrog, in North Wales, and about 1,200 ft. above it, failed during the evening of November 2, through scouring out of a 30-ft. section of the clay underlying the footings. The water discharging from this opening caused the overtopping and in a short time the complete failure of an earth dam much closer to, and 900 ft. above, the town of Dolgarrog. The rush of water from the reservoir back of this lower dam down a steep hillside carried great masses of earth and huge boulders into the town causing the death of 16 persons and doing a large amount of damage. The flood waters submerged the generators in the power house and cast the whole area into darkness, and entered the plant of the Aluminum Corp. and caused an explosion of the reduction furnaces.

The general arrangement of the storage reservoirs of the North Wales Power Co. above its Dolgarrog plant is shown in the accompanying map, Fig. 1. The surface of Lake Eigiau has been raised by the construction of a dam about three-fourths of a mile long. Water from this reservoir is discharged into the natural stream channel as required in the service reservoir, Lake Coedty. Water from Lake Cowlyd is brought into the service reservoir in an artificial channel. From the service reservoir penstocks deliver the water to the power plant in the valley.

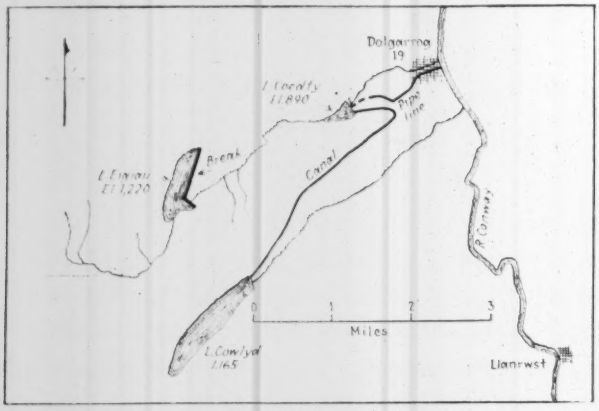

FIG. 1—LAKES AND RESERVOIRS ABOVE DOLGARROG

The dam on Lake Eigiau is L-shaped in plan. It consists of 3,300 ft. of gravity section concrete wall and 1,300 ft. of low embankment at one end. The maximum height above ground level is about 20 ft. The capacity of the reservoir is 160 m.cu.ft. Construction of the dam was started in 1907, but work was stopped in 1908 and the dam was not completed until the years 1910-11.

The Lake Coedty dam is an earth-fill structure with a concrete core wall. The spillway of this dam, designed for maximum flood flow conditions, is over the side of the artificial channel from Lake Cowlyd where the latter swings around the side of the mountain below the Lake Coedty dam. It was inadequate for such an enormous flood and the earth-fill dam was overtopped and washed out. No warning reached the town as the telephone line from Lake Eigiau was washed away while the operator there was waiting to call through.

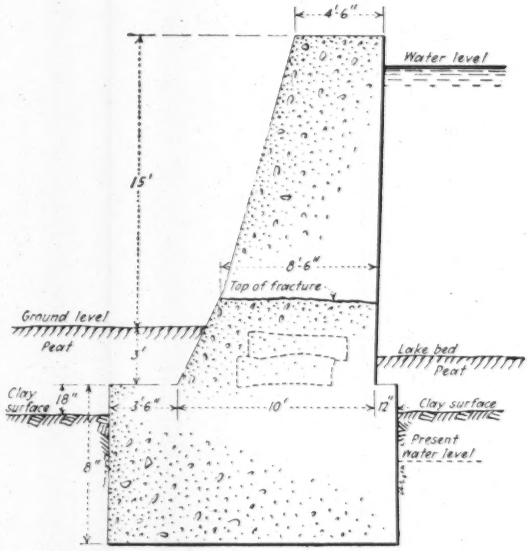

FIG. 2—SECTION OF LAKE EIGIAU DAM AT POINT OF FAILURE

Cause of the Failure—Failure of the Lake Eigiau dam was due to undermining near the junction of the 1908 and 1910 work, a point where the dam is only 15 ft. high above ground level. A breach about 30 ft. long and 10 ft. high, extending up into the concrete wall itself, was washed out under the dam.

The whole structure is built upon a glacial deposit

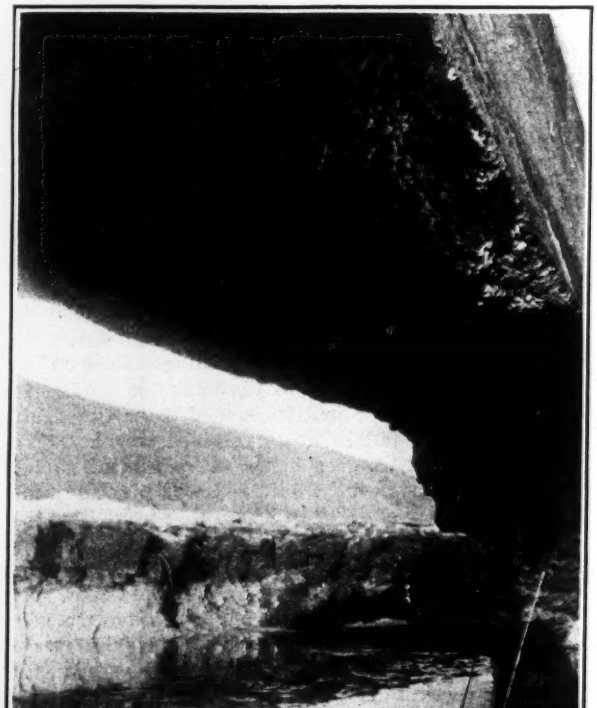

FIG. 3—UNDERSIDE OF DAM OVER OPENING
One of the large stones in the concrete shows in the plane of fracture.

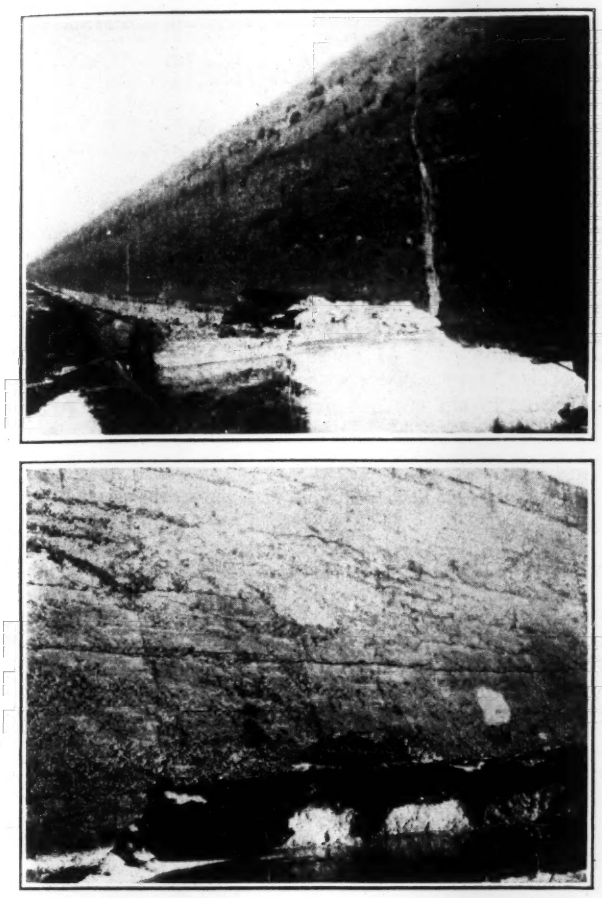

FIG. 4—LAKE EIGIAU DAM
Above: Inside face at point of fracture. Below: Exterior face at the same point.

of hard blue clay containing boulders of granite, which deposit lies at a depth of 2 to 3 ft. below a surface layer of peat. The footings of the dam, according to the design to which it was supposed to have been built, were to have been carried to a depth of 6 ft. below the surface of the clay, as shown in Fig. 2, but it appears from the examination of an engineer who visited the dam at our request, and also from the testimony at the coroner's inquest, that at the point where failure occurred the footings were carried only to a depth of 18 in. into the clay—shallow footings were 1908 work.

Not only were these footings not built according to plan but the concrete was poor. Fig. 3 shows the under side of the remaining portion of the dam above the opening. One of the large blocks of stone in the concrete which were exposed by the failure can be seen in the picture. Two others, about 4½ ft. wide and 1½ ft. high, are exposed in the vertical face of the break. About 50 per cent of the surface of these two stones shows no sign of having been covered with cement. About 3 ft. above the opening is a long horizontal crack indicating another plane of weakness.

In recent years the dam has leaked considerably and during periods of low water it had been patched in many places. Some of these patches show in Fig. 4.

Last summer the lake was dry for a considerable period and, according to the testimony at the coroner's inquest by Ralph Freeman, a member of the firm of Sir Douglas Fox & Partners, engineers, under whom as consultants the dam was finally completed in 1911, it is probable that the clay became dried out and shrank and developed fissures, which, when the reservoir was filled quickly by the fall rains, provided openings through which water began to work under the dam. Flow through these openings enlarged them until underscour and failure of the dam occurred. An attendant at the dam testified that he had noticed the swampy nature of the ground near the point of failure. He said, however, that he thought the water came from springs.

Testimony by A. R. Harper, of the firm of Harper Bros. & Co., who were the engineers during the construction of the first part of the dam, was to the effect that the place of the fracture was within the portion constructed when Harper Bros. were alone the engineers for the reservoir and that if the concrete put there was defective it might have been the fault of their employees that concrete was badly mixed; that his firm never completed the contracts of 1907-8 and was not paid for the last section of the work done, which was never certified by them. Lionel P. D. Taylor, resident engineer on the work for the firm of Harper Bros., in testifying concerning the foundations and the quality of the concrete said that his headquarters at the time were at Dolgarrog and that the supervision of the work at Lake Eigiau was in the hands of a man named Wilson, then 65 years of age and now dead, who was responsible for the mixing of the concrete and the depth of the foundations. Mr. Taylor testified that Mr. Wilson was a very conscientious man, strict with the contractors. Questioned as to the large stones in the concrete he said that the placing of plums in the concrete was allowed. The contracting firm of Bott & Sennett which built the dam is now out of existence.

The coroner in his summing up stated that the failure was evidently due to criminal neglect upon the part of some one now unknown. The jury rendered a verdict of "accidental death caused by the bursting of Lake Eigiau dam and on the evidence a section of the wall lacked proper foundation." The jury recommended that the remaining portion of the dam be examined by government inspectors before reconstruction.

FIG. 5—REMAINING PORTION OF LAKE COEDTY DAM

The information upon which this report is based was obtained in part from an examination of the structure by Hugh Samuel, a civil engineer of Wrexham, Wales, and from press reports of the coroner's inquest.

Gravel Roads Cheaply Surfaced with Asphalt

Michigan Is Covering Old Gravel Roads With Sheet Asphalt at a Cost of About a Dollar a Yard—Reports and Cost Records

A SHEET asphalt top is being put on a considerable mileage of Michigan's gravel roads. With a big system (3,400 miles) of well built and kept-up gravel trunk line highways growing traffic is every year putting more miles to a service where maintenance becomes excessive. In these instances frequently the demands of traffic do not warrant a paved road but do make necessary some more durable surfacing than gravel. Here it is that it is believed a sheet asphalt topping offers a construction which at least bridges the period after gravel has ceased to be sufficient until hard paving is justified or can be afforded. There seems to be good evidence that this faith is justified. Most of the state's mileage of asphalt surfacing of gravel has been built within the last two or three years but there are examples eight years old of such surfacing in good condition except for ragged edges due to lack of attention to shoulders by local maintenance.

Types of Surfacing—In general two types of surfacing are employed: (1) Where the present gravel surfacing has to be widened and (2) where the old gravel road is the full width to be surfaced. Examples of the two types are given by Fig. 1.

Sufficient black base is called for to smooth to profile the old gravel surface. This may be little or much as the old surface is well kept or has become worn or rutted. It has to be kept in mind that the old compacted gravel is not rooted up and reshaped or shaped up with new gravel. The essence of the construction is to preserve intact the old compacted gravel, but to clean off all loose material and correct the profile with

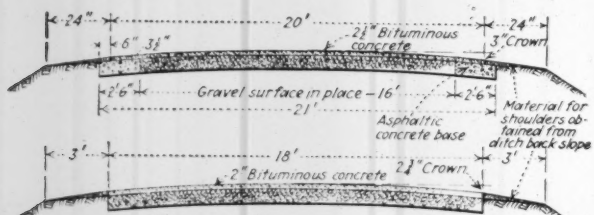

FIG. 1—TYPICAL ASPHALT-SURFACED GRAVEL ROADS

black base. The ideal situation structurally and economically is when the old gravel has only to be swept and tarred to be ready for surfacing.

When the old gravel surface is narrow, widening is done with black base as shown by Fig. 1. It will be noted that the black-base strips are carried out half a foot wider than the surfacing. This gives a good support against raveling down of the edges of the sheet asphalt. The widths of asphalt surfacing are either 18 ft. or 20 ft., and wherever the old gravel is narrower it is widened by black base.

Construction Process—Construction begins with cleaning the old gravel surface. It is swept clean. Then it is dressed with ¼ gal. of tar a square yard, using the ordinary tar distributor and methods. The penetration is about ¼ in. In rare instances the gravel surface is in such shape that after tarring, the asphalt top can be laid at once. Usually the tarred surface has to be dressed up with black base. In some of the work this amounts to no more than filling an occasional hole, but generally it is enough in volume to require a roller and often it is a virtually continuous binder course of considerable yardage as indicated by the job output records given further on.

With the old surface brought to profile, side forms

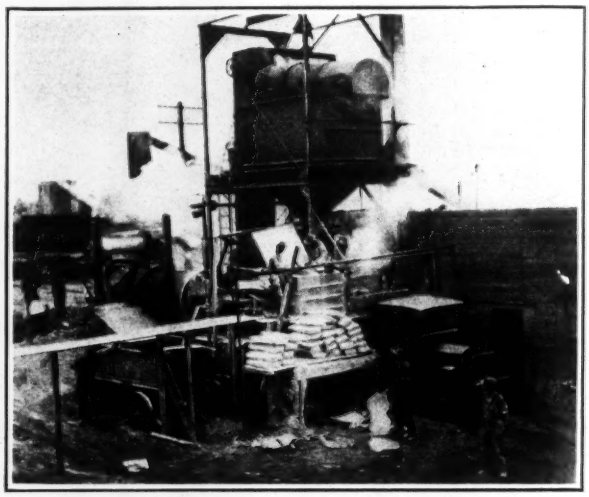

FIG. 2—ASPHALT PLANT OPERATED BY STATE

of 2x6-in. timbers are laid flat and spiked down. The timbers are in 12-ft. lengths with three spikes to a timber. Putting on the top is done with as exacting care as in sheet asphalt paving anywhere. Standard specifications as to materials, mixtures, temperatures, and haulage prevail. In placing the usual requirements as to separate dumping, complete shovel spreading, and raking from off the material prevail. It is in rolling that especial methods are followed.

No less than four rollings, with machines of different weights, are given the asphalt. As soon as the top is spread it is rolled crosswise with a 1,500-lb. hand roller. This gives the preliminary smoothing and discloses the thin spots before any considerable compression. There follows a longitudinal rolling with a 3-ton machine for the preliminary compression. Then the pavement is rolled diagonally with a 5-ton machine and finally given the finishing compression with a 7-ton roller. Each rolling follows customary practice in respect to lapping, adding material to and rerolling thin spots. Templeting, ironing and cement dusting also are according to usual practice.

In the full-page group of views each of the operations in the sequence described is illustrated. These views are of work done by the state by force account, using both free labor and prison labor organized and managed as described in a succeeding article on concrete road work.

Form No. 250-1

Length 7.741 MICHIGAN STATE HIGHWAY DEPARTMENT Project T.L.13-68
County St. Joseph DAILY PLANT REPORT Section
Type 2½" Asph. Conc on 7" Treated Gravel ASPHALTIC CONCRETE OR SHEET SURFACE Report No. 33
Date 7/23/25

NOTE—Total Labor Must Check with Actual Amount of Checks Issued at Pay Roll Period

		Hours	Rate	Amount	Distribution of Pay Roll	Amount
1	Foreman	5	.833	4 11	Yard	63 26
1	Engineer	5	.70	3 50	Haul	15 00
2	Clerk	10		5 62	Unload Sand	15 00
1	Tankmen	5	.70	3 50	Unload Stone	
3	Mixerman	15	.70	10 50	Unload Dust	
1	Firemen Drum	5	.70	3 50	Unload Coal	
17	Laborers	65	.50	32 50	Idle Time	
		5	.60	3 00		
1	Teams	5	.85	4 25	Plant Repairs	
7	Trucks Drivers	35	.50	17 50	Truck Repairs	6 33
2	Truck Mechanic	10		6 33	Plant Erection	
1	Checker	5	.40	2 00	Moving Plant	
1	Night Fireman	5	.643	3 27		
	Total Pay Roll			99 59	Total Pay Roll	99 59

Materials Used				Work Done	
Gas-60 gals					
Fuel Oil 250 gals.				Surface Boxes 200	
A. C. 18200 lbs.	Gravel		lbs.	Labor per Box .32	
Flux lbs.	F. Sand	54.0 Tons	lbs.	Haul per Box	
Stone 46600 lbs.	C. Sand		lbs.		
Dust 27200 lbs.	Coal	2.0 Tons	lbs.		
Wood Cords	Kerosene	20	gals.	Remarks	
Lubricating Oil 3			gals.		
Boiler Compound			lbs.	Weather Fair	
A. C. per Box 91 lbs.	Gravel per Box		lbs.	Cause of Delays	
Stone per Box 233 lbs.	Dust per Box 136		lbs.	No. Boxes per Load 7	
C. Sand per Box } 546			lbs.	Average Length Haul this Date	
Fine Sand per Box }			lbs.	Hours Plant Operated 10	
Oil to 100 lbs. R. A.				John. Dewitt Foreman	

FIG. 3—PLANT REPORT FOR ASPHALTIC CONCRETE OR SHEET SURFACE

Records and Costs — A round figure of cost of asphalt surfacing gravel is $1.20 a square yard. On the state work close accounts are kept by the highway department. Daily reports are made of plant costs and production of surfacing and of binder. Two daily field reports are also made, one covering asphalt laying (surface and binder) and the other covering grade and shoulders. These are records for the field office. Each day they are combined into a consolidated daily report which is sent to headquarters at Lansing. These daily reports are the original records for the final accounting.

To provide some details, one day's complete records are given of a 7.741-mile, 7-in. gravel road being surfaced with 2½-in. asphalt in St. Joseph County. Plant and field operations were observed and a fairly representative day's records were selected. The type of asphalt plant is that shown by Fig. 2. The field outfit comprised the rollers described, trucks for hauling binder and surfacing and the usual asphalt paving tools. In one respect this operation was exceptional as asphalt surfacing work has run in Michigan. The old gravel was in bad repair and a virtually complete covering of black base was required to bring the surface to profile. This accounts for the volumes and costs of binder in the daily records given.

The plant report form is shown by Fig. 3; it gives the actual figures for surfacing. On the same day using the same form the output of binder given in the table (p. 16) was reported. The field report form and the

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Length 7.741 MICHIGAN STATE HIGHWAY DEPARTMENT Project T.L.13-68
County St. Joseph DAILY FIELD REPORT Section
Type 2½" Asph. Conc on 7" Treated Gravel ASPHALTIC CONCRETE OR SHEET SURFACE Report No. 33
Date 7/23/25

NOTE—Total Labor Must Check with Actual Amount of Checks Issued at Pay Roll Period

		Hours	Rate	Amount	Distribution of Pay Roll	Amount
1	Foreman	10	10.00	10 00	Lay Surface	108 25
3	Rollermen	30	7.50 6.00 5.00	25 50	Moving	
3	Watchman	30	5.00	15 00	Idle Time	
4	Rakers	40	7.50	30 00	Roller Repairs	
2	Smoothers	20	6.50 5.00	11 50	Lay Binder	108 25
2	Tampers	20	6.50 7.50	13 50		
4	Shovelers	40	6.00	24 00	Rec'd 273 Boxes Binder	
12	Laborers	120	5.00	60 00	Layed 1500 feet by 20' Wide	
1	Waterboy	10	3.00	3 00		
1	~~Wagon~~ Truck Driver	10	5.00	5 00		
3	Form Setters	30	7.00 6.00 6.00	19 00		
	Total Pay Roll			216 50	Total Pay Roll	216 50

Work Done		Remarks	
Sq. Yds. in Contract	81312	Weather Fair	
Sq. Yds. Previously Laid	10699	Kind of Base Treated Gravel	Thickness 7"
Sq. Yds. Laid this Date	1050	Thickness Binder	1"
Sq. Yds. yet to do	69563	Thickness Surface	2"
Surface Boxes Used	200	Cause for Delays None	
Yardage per Box	5.2	Surface Laid Sta.	to Sta.
Labor per Sq. Yd.	10.3	Shop Repairs—Where Done	
Materials Used on Street		Cost	
Cement 3 Bags From			
A. C. lbs.	Coal 1000 lbs.		
Lub. Oil 1 gals.	Wood cords		
Gasoline 15 gals.			
Kerosene 25 gals.		E. A. Foltz Foreman	

FIG. 4—FIELD REPORT FOR ASPHALTIC CONCRETE OR SHEET SURFACE

record for the day selected are shown by Fig. 4. On the same day there were recorded wages of 1 foreman and 14 laborers on grading and shoulders, with a pay-roll of $78.33, and the use of 1½ gal. of oil and 50 gal. of gasoline. The combination of all figures into a consolidated daily report form is shown by Fig. 5. It will be noted that only materials and labor costs are given. Overhead management and other general costs are apportioned in the accounting done at headquarters.

The above accounting is planned to be complete and to include every detail of overhead expenses which by any reasoning can be legitimately charged against state operations.

Length 7.741
County St. Joseph
Type 2½" Asph. Conc. on 7" Treated Gravel

MICHIGAN STATE HIGHWAY DEPARTMENT
BITUMINOUS PAVEMENT
CONSOLIDATED DAILY REPORT

Project T.L. 13-68
Section
Report No. 33
Date July 23, 1925

Binder				Shoulders (Surface) - Grade				Asphaltic Concrete			
Material	Quantity	Unit Price	Amount	Material	Quantity	Unit Price	Amount	Material	Quantity	Unit Price	Amount
Asp. Cement	14742	.01112	163.93	Asp. Cement				Asp. Cement	18200	.01112	202.38
Stone Tents, etc.			191.00	Dust				C. Sand	54.0	1.70	91.80
Gravel	86.09	.10	8.61	C. Sand				F. Sand Truck Repairs			40.00
C. Sand				F. Sand				Stone	46600	.00109	50.79
Dust				Coal				Dust	27200	.003	81.60
Coal	2.0	5.10	10.20	Cement				Coal	2.5	5.10	12.75
Lubricating Oil	3.0	.71	2.13	Lubricating Oil	1.5	.71	1.07	Cement	0.75	3.00	2.25
Boiler Compound Waste	5.	.10	.50	Boiler Compound				Lubricating Oil	4	.71	2.84
Gasoline	60	.214	12.84	Gasoline	50	.214	10.70	Boiler Compound			
Kerosene	30	.128	3.84	Kerosene				Gasoline	65	.214	13.91
Wood Fuel Oil	250	.067	16.75	Wood				Kerosene	35	.128	4.48
Demurrage				Demurrage				Wood Fuel Oil	250	.067	16.75
				Labor			78.33	Demurrage			
Total Cost Material			409.80	Total Cost Material				Total Cost Material			519.55
Labor				**Labor**				**Labor**			
Street Pay Roll			108.25	Street Pay Roll				Street Pay Roll			108.25
Plant Pay Roll			101.70	Plant Pay Roll				Plant Pay Roll			99.59
Tools, Machinery, Supplies			409.80	Tools, Machinery, Supplies				Tools, Machinery, Supplies			519.55
Total Cost this Date			619.75	Total Cost this Date				Total Cost this Date			727.39
Work Completed				**Work Completed**				**Work Completed**			
Sq. Yds. in Contract				Sq. Yds. in Contract				Sq. Yds. in Contract	81312		
Sq. Yds. Previously Laid				Sq. Yds. Previously Laid				Sq. Yds. Previously Laid	10699		
Sq. Yds. Laid this Date				Sq. Yds. Laid this Date				Sq. Yds. Laid this Date	1050		
Sq. Yds. Yet to Lay				Sq. Yds. Yet to Lay				Sq. Yds. Yet to Lay	69563		
Cost Sq. Yd. this Date				Cost Sq. Yd. this Date				Cost Sq. Yd. this Date	.69		
Weather				Weather				Weather Fair			
Thickness				Thickness				Thickness			
Brand of Asphalt				Brand of Asphalt				Brand of Asphalt			
Cost of Black Base a ton $4.54											

Supt.

FIG. 5—CONSOLIDATED DAILY REPORT OF ASPHALT SURFACING OPERATIONS

PLANT CREW, PAYROLL AND MATERIALS FOR BINDER OUTPUT JULY 23, 1925

Plant Crew

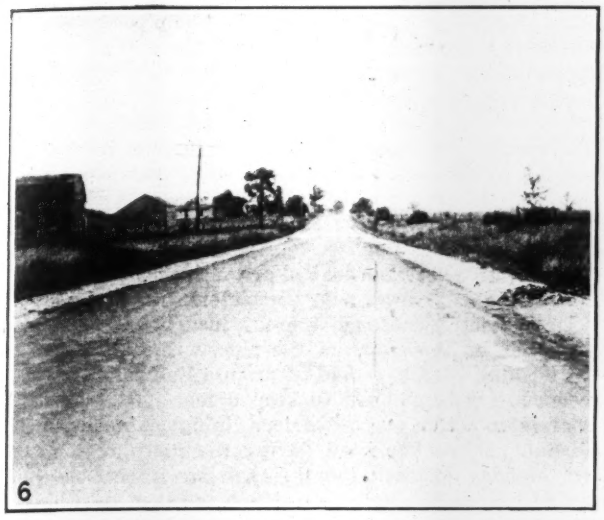
	Hours	Rate	Amount
1 Foreman	5	.833	$4.16
1 Engineer	5	.70	3.50
2 Clerks	10	..	5.62
1 Tankman	5	.70	3.50
3 Mixermen	15	.70	10.50
1 Fireman Drum	5	.70	3.50
17 Laborers	65	.50	32.50
	5	.60	3.00
2 Teams, 1 man	9	..	6.38
7 Truck Drivers	35	.50	17.50
2 Truck Mechanics	10	..	6.33
1 Checker	5	.40	2.00
1 Night Fireman	5	.653	3.21
Total Payroll			$101.70

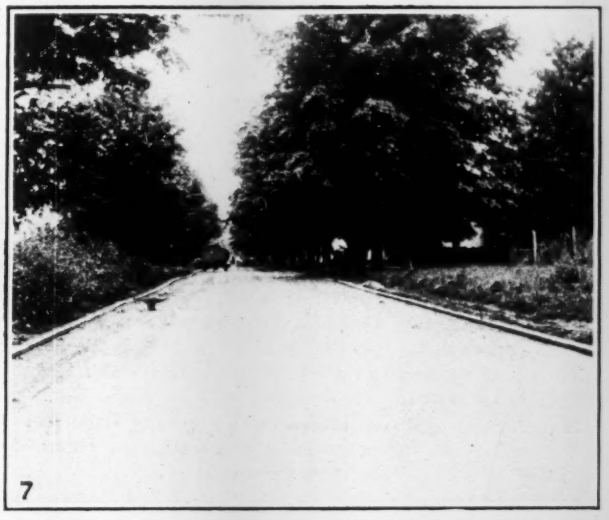
Distribution

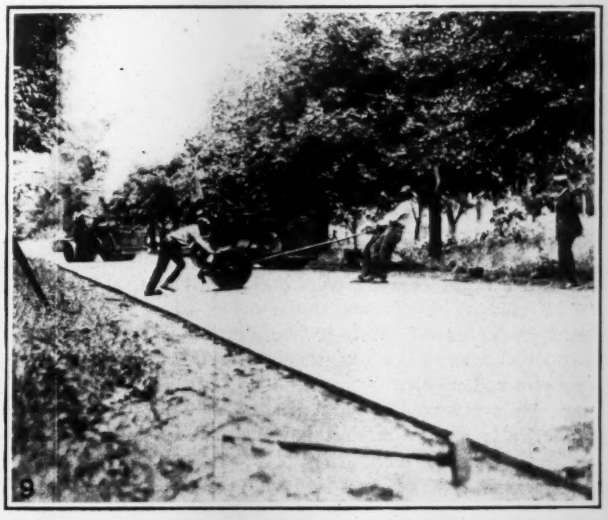
Yard	$65.37
Binder	15.00
Sand	15.00
Truck repairs	6.33
Total	$101.70

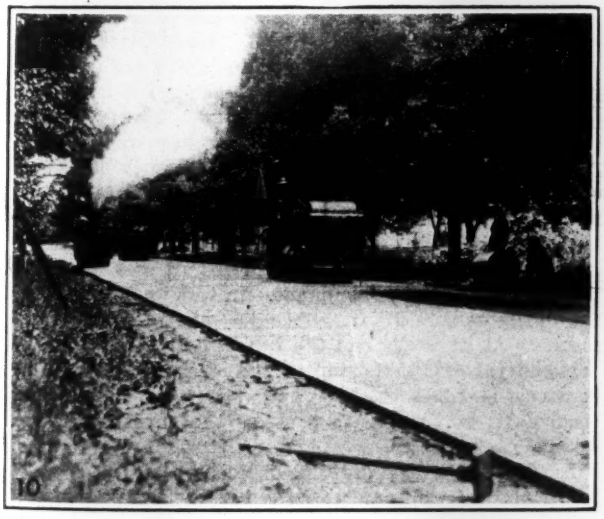
Materials Used

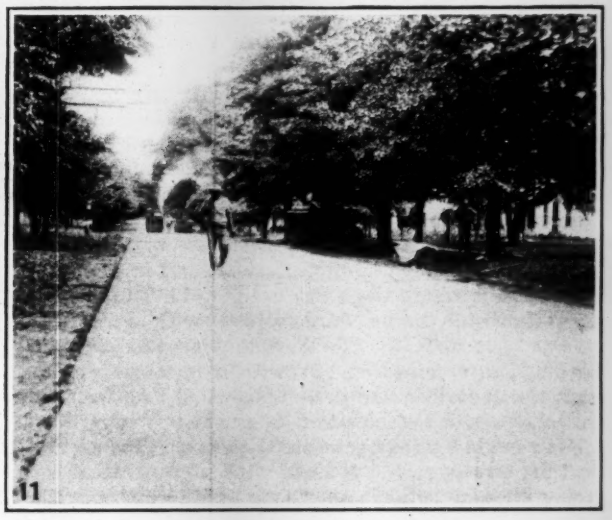
Gas	50	gal.
Fuel oil	250	gal.
Asphalt cement	14,742	lb.
Gravel	86.09	yd.
Kerosene	20	gal.
Coal	2	tons
Lubricating oil	3	gal.
Waste	5	lb.
A. C. per box	54	lb.
Gravel per box	946	lb.
Binder boxes	273	
Labor per box	27	c.











FIGS. 6-11—SURFACING GRAVEL ROADS WITH ASPHALT

Fig. 6—Section of tar-treated gravel with untreated road in the distance. Fig. 7—Wood forms laid along sides ready to be lined up and spiked down. Fig. 8—Asphaltic concrete surface being placed. Fig. 9—Cross-rolling immediately back of raking with 1,500-lb. roller. Fig. 10—Three power rollers, 3-ton, 5-ton and 7-ton in operation. Fig. 11—Dust being broomed into finished surface. The operations are performed in the order of these illustrations.

The work is under the direction of the Michigan State Highway Department, Frank F. Rogers, state highway commissioner, and G. C. Dillman, deputy commissioner and chief engineer.

Sewer Lining Experiments for Los Angeles County

Bypass Composed of Various Materials—Joints, Linings and Coatings Subjected to Flow of Septic Sewage

By A. M. Rawn
Assistant Chief Engineer, Los Angeles County Sanitation Districts, Los Angeles, Calif.

IN CONNECTION with the construction of the Los Angeles County metropolitan system of sanitary sewers, the necessity of providing against the deterioration of concrete in the presence of extremely septic sewage presents itself forcibly, particularly in the joint outfall trunk sewer. This outfall will be some thirty miles in length, and will intercept the sewage from five county sanitation districts and a portion of the city of Los Angeles, and convey it to the ocean.

Investigations conducted by the city of Los Angeles, where a similar condition has been met, led it to adopt a vitrified clay block inner lining for all concrete pipes and conduits in the city's sewer system, wherein the sewage remains long enough to become septic. In the absence of a better and cheaper substitute clay lining blocks have been proposed for the county sewer system. But since the construction of the city's system, several types of inner linings have been presented to the engineer of the county sanitation districts, with limited data supporting the merit of each. In order that the relative resistance of each type of lining available might be studied under actual working conditions, the engineer of the districts was authorized to construct an experimental sewer line, in which would be installed pipes lined with acid resisting materials and coatings of recognized merit.

Selecting a location near the lower end of the Los Angeles city north outfall sewer, at which point the sewage is as septic as any available and compares favorably with that which will be encountered in the county outfall, a 36-in. circular experimental sewer line has been constructed as a bypass close to the outfall sewer and was placed in operation on Dec. 7, 1925.

Structurally, the bypass consists of quarter bends at each end and seven 12-ft. sections, with five manholes to give access to the sections—a manhole over each quarter-bend connection and three manholes between. One of the 12-ft. sections is subdivided into three, as to lining only. Section 1 is of Ferguson segmental clay and sections 2 to 7 are of reinforced concrete.

Further variations in the sections lie in the lining, coatings or paintings of the interiors, and in the jointing materials where these are used: (1) The vitrified clay segmental linings are joined with Petrolastic cement. (2) and (3) The Ferguson vitrified clay lining blocks are joined in (2) with a mixture of sand, sulphur and carbon, known as Calco Acid Proof cement, and in (3) with Petrolastic XX cement.

The remaining four reinforced-concrete pipe sections are thus treated: (4) is lined with a preparation consisting of sand, sulphur and finely ground diatomaceous earth; (5) has a thin wash coat of sand, sulphur and carbon, known as Calco Acid Proof cement; (6) is painted on the inside with a coal tar product known as Biturine; (7) of the three 4-ft. lengths of pipe, the interior painting of (a) is a specially prepared coating of coal tar, of (b) USSCO Concrete Hardener, of (c) a specially prepared asphaltum. The two pipes connecting the experimental line with the north outfall sewer are painted on the inside with a bituminous preparation known as Inertol.

The five manholes are constructed with concrete base and common clay sewer brick walls, laid up in a 1:2 cement mortar. The walls of the manholes are untreated, as are the joints between sections of pipe; therefore they will serve to indicate the intensity of acid action in the line.

Conditions of sewage control are such that the experimental line will never run completely full of sewage or be completely emptied, thereby insuring a constant gas action on the crown of the pipe, without intermittent flushing such as would occur in a line running full at times. It is planned to keep a monthly record of progressive action on the various lining materials, and the line will be inspected during the morning of the first Monday of each month. During inspection the line will be temporarily emptied of sewage.

The Los Angeles County Sanitation Districts sewer system is being constructed under the direction of A. K. Warren as chief engineer with the writer serving as assistant chief engineer.

Efficiency Test on High-Head Reaction Turbine

Oak Grove Unit on Portland System Shows 90 Per Cent Efficiency at 35,000 Hp. Under 882-Ft. Effective Head

TESTS have recently been made on Unit 1 in the Oak Grove plant of the Portland Electric Power Co., which were planned to determine efficiency and output in the hydraulic turbine at various gate openings. Results are reported to be highly satisfactory to company officials. The turbine is a vertical reaction wheel rated at 35,000 b. hp. and designed for highest efficiency under a head of 849 ft. with the prescribed generator speed of 514 r.p.m. In this test the turbine was operated under an effective head of 882 ft. but was held to a speed of 514 r.p.m. Hence the efficiency was less than is expected when later units are installed and the turbine can operate under the speed and head conditions for which it was designed. The generator is rated at 30,000 kva. with an 85 per cent power factor.

The conduit system supplying the unit begins at the intake with a concrete duct 12 ft. 4 in. in diameter and 1,540 ft. long. Thence a 9-ft. steel pipe, 33,920 ft. long *(Engineering News-Record*, Dec. 27, 1923, p. 1067) leads to a tunnel 14 ft. in diameter and 467 ft. long, through the knoll above the power plant. In this knoll is located the surge tank, 197 ft. above the center line of the tunnel. At its lower end the tunnel delivers through a Johnson valve into the top of the steel penstock. The penstock is 1,300 ft. long and decreases in diameter from 8 ft. at the top to 5 ft. at the entrance to the turbine casing.

In the tests on the unit the objectives laid down were to calculate the efficiency of the turbine, its power output in terms of brake horsepower, the flow of water through the unit in second-feet, and the effective head under which the turbine operates.

The power output of the turbine was determined by measuring the generator load in kilowatts at unity power factor and converting it into horsepower; taking

into account the generator efficiency. The kilowatt load was measured by means of two single-phase, portable standard wattmeters which had been carefully checked. The performance of the flow line had been established previous to the test by the use of multiple Pitot and piezometer tubes—a method worked out by D. W. Proebstel, superintendent of tests for the company. This method is a form of the old Pitot tube method but differs from it in that many fixed tubes and nozzles are used instead of one or two movable tubes. The tubes connect to a series of glass manometer tubes arranged to indicate the velocity heads at the centers of predetermined cross-sectional areas in the pipe line.

READINGS TAKEN IN COURSE OF EFFICIENCY TEST ON OAK GROVE UNIT

Turbine gate opening	0.15	0.2	0.3	0.4	0.5	0.6	0.7	0.8
Servo-motor opening, in.	1.375	1.625	2.50	3.19	3.81	4.625	5.31	6.06
Turbine output, hp.	10,902	14,515	21,964	28,083	32,470	35,544	36,953	37,489
Static head (surge tank less tailrace elevation)	919.5	916.95	910.3	903.8	894.75	888.25	883.25	879.2
Penstock, friction and velocity head, ft.	1.36	2.09	4.71	7.12	8.80	11.0	12.35	13.20
Pressure head, penstock	695.64	694.91	692.29	689.88	688.20	686.00	684.64	683.80
Velocity head, turbine entrance	0.55	1.12	2.35	3.74	5.03	6.28	7.26	7.90
Tailrace head	3.50	3.45	3.30	3.30	3.25	3.25	3.25	3.20
Effective head	916.13	911.30	902.83	897.19	889.82	879.63	876.95	869.76
Quantity of water, sec.-ft	126.36	166.82	241.83	305.00	353.60	395.03	424.61	443.15
Turbine input, hp.	13,133	17,247	24,770	31,045	35,696	39,422	42,244	43,727
Turbine efficiency	0.830	0.842	0.886	0.905	0.910	0.902	0.875	0.857
Drop in head at surge tank	5.30	7.80	14.20	20.60	29.60	35.95	40.95	44.95
Mean velocity, sec.-ft	2.00	2.62	3.80	4.79	5.56	6.21	6.67	6.97

Manometer readings were recorded by means of a camera.

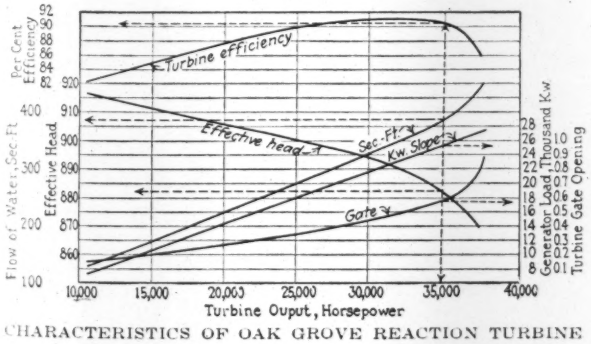
The effective head on the turbine (American Society of Mechanical Engineers test code standard) was taken as the sum of (1) the penstock pressure head measured at the center line of and adjacent to the turbine entrance, (2) the velocity head at that point and (3) the draft head or the difference in elevation between the point just described and the tailrace water, less the velocity head at outlet of draft tube. Head measurements were made by subtracting losses from surveyed static head. In other words, the total pressure head was determined by using the pressure head at the center line of the Johnson valve at the upper end of the penstock and adding to it the pressure head at the turbine entrance. The latter was determined by deducting from the vertical height between the turbine and the Johnson valve, the velocity and friction head in the penstock and the valve determined by means of a differential mercury manometer placed at the turbine entrance. A small pipe connected to the tunnel just above the Johnson valve and carried downhill to the turbine entrance was used to impress static head on the manometer. The friction and velocity heads were calculated as follows: $h = H_m(M_w/W_w - 1)$, where H_m is the mercury head in feet and M_w/W_w is the specific gravity of mercury taken as 13.57. The velocity head at the turbine entrance, $h_v = Q^2/2gA^2$, where Q is the quantity of water in second-feet, A the area in square feet of the turbine entrance, and g the acceleration of gravity, 32.2. Water levels at intake and the tailrace were read from gage boards. The elevation in the surge tank was read from a water-gage indicator in the power house.

The term "turbine gate opening" used in the accompanying table refers to the uniform scale markings on the index gage carried by the governor. In order to define these indications in terms of actual movement of the turbine gate mechanism, measurements of the servomotor openings are listed under the gate-opening records.

With all testing apparatus checked and adjusted, the first load setting was made at 0.15 turbine gate opening. Telephones were used for intercommunication and simultaneous readings were taken by observers at the several stations. Turbine gate openings were increased by stems of 0.05 for each successive load setting up to 0.5 gate and then by 0.1 gate increases up to 0.8 gate, the last load setting at which readings were taken. Some of the detailed readings made in the course of the test are given in the accompanying table.

The curves reproduced show the characteristics of the turbine for the conditions under which the test was conducted. The termination of the gate-opening curve, it is pointed out, indicates that but very little additional power could be carried by the unit beyond 0.8 gate opening.

The tests were conducted under the supervision of D. W. Proebstel, superintendent of tests, Portland Electric Power Co., to whom *Engineering News-Record* is indebted for the foregoing data.



CHARACTERISTICS OF OAK GROVE REACTION TURBINE

Springfield Slow Sand Filters Doubled

The water filtration plant of Springfield, Mass., has been enlarged to a little more than double the original capacity—rated at 15 m.g.d. and operated easily at 12 m.g.d. The original plant, built at the time of the construction of the Little River additional supply and put in use Jan. 8, 1910, consisted of six slow sand filters, each with a net area of 0.52. The additional beds are four in number, each of a net area of 0.82, immediately adjoining the old beds. The new plant is very much like the old one. Sand bins have been substituted for the sand court previously used for the storage of washed filter sand. The water is coagulated through periods when the color is noticeable and delivered into an open sedimentation basin, from which after about 24 hours, the water passes through a rock crib into a still larger basin. From the latter basin water is drawn with or without aeration for delivery to either the old or the new plant. The population of Springfield by the federal census of 1920 was 129,614 and by the state census of 1925 was 142,224. The system supplies not only the needs of Springfield, but also many of the surrounding towns. E. E. Lochridge is chief engineer of the Springfield water-works.

Road Progress in the South Atlantic and Gulf States

South Carolina	Louisiana
Georgia	Florida
Alabama	Mississippi

An Editorial Field Study of State Road Organization, Policies and Plans; the Trend of Highway Thinking; the Status of State Control; and the Progress in Engineering and Construction in Six Southern States

By Frank C. Wight
Editor, *Engineering News-Record*

V—Florida

FLORIDA is today the most spectacular of the forty-eight states. A land boom beyond all precedent in this country of land booms is at its height and literally hundreds of thousands of people are pouring into the state this year by ship, railroad, and motor car. The sidelights of this boom as observed in a three weeks' trip through the state are to be treated in an article in *Engineering News-Record* of Jan. 14, but the road system is so intimately a part of the current development of the state that a special study of its development has been made as a part of the current series of investigations on the southeastern road situation.

Florida's roads are of comparatively recent development as modern highways. It was only a short time ago that the narrow roads of Florida were a byword in the mouth of every one who went there. Nine-foot widths were the standard of the best types, and the secondary pathways through sand and swamp were hardly so wide. Today the situation is changed. The state has a standard of 66-ft. right-of-way with 18-ft. paved surface and rolled and grassed shoulders of easy slope permitting ready turnout of the car upon them, and the counties following the state lead are in many places equaling or bettering this high standard. The state is spending around $10,000,000 a year on a pay-as-you-go policy for its roads, and the counties, in the mad rush of real-estate development, have been issuing bonds so fast that there apparently is in the state no authentic or official record of the total to which they have gone. The estimate, however, at Tallahassee, is that there are outstanding some $150,000,000 worth of bonds for roads by the 62 counties of Florida.

History of Development—This road development, as in all the other states of the South, began only after the Federal-Aid Act of 1916 was passed. The Florida Road Department was organized in 1915, following the first intimation of federal aid, but for two or three years it got no money from the federal government nor did it have sufficient state appropriation to permit it to do other than general publicity work. The general attitude of the counties at that time was not favorable to state-controlled roads and this antipathy extended to the Legislature which though it had formed the department did not encourage it by any considerable appropriation. However, the department organized and held a number of meetings. It specialized in going around the state and interviewing county officials. It found that the counties needed advice and that they sometimes wanted it, but rarely would they take it, and the legislators continued to be advised by the county authorities not to appropriate any money.

However, in 1919 enough educational work had been done so that the Legislature put a 2-mill tax on all property, turned over the highway department a certain percentage of the automobile license money and assigned some of the convict labor of the state to the road work. In that year the department had about $600,000 to spend.

In January, 1920, the department was really launched. A thousand convicts were turned over to it for work and a $2,000,000 federal-aid road system was approved by the federal government. The 2-cent gasoline tax, about 75 per cent of which had to go for construction, was continued and the state spent a total of about $3,000,000. In 1923 the gasoline tax was continued, auto licenses raised and a gas inspection fund devised, which, with a 1-mill tax for that year, gave the department $4,000,000. In 1924 this went up to $6,000,000 and as the counties commenced to get confidence in state work, they commenced turning over to the state funds which in that year amounted to $2,000,000 for county work.

In the current year the state is spending about $10,000,000 divided as follows: 4c. gasoline tax, $6,500,000; 3-mill tax, $500,000; automobile license fees, $2,500,000; federal aid, $850,000. The gasoline tax is 4c., of which the state gets 3c. and each county 1c., all of which is to be used in road work. The county gets its gasoline tax quota pro rata to the number of counties and not in proportion to the number of automobiles registered in the county or population or any other factor.

Up to 1923, the department laid out its own roads, but in that year the Legislature set up a state-wide system of 3,600 miles of road with six main trunk lines on preferential roads and ordered the department to spend its money on nothing else. In 1925 this was amended to add 1,800 miles more to a second preferential road system. These totals include, of course, the federal 7 per cent system.

Organization—The State Road Department is composed of five members, one from each of the four congressional districts and one at large. This commission elects its own chairman, who gets a salary of $7,500 a year and expenses; each of the other four members get $50 per month and expenses. The present chairman is Dr. Fons A. Hathaway, of Jacksonville, who became member and chairman on July 25, 1925. Dr. Hathaway is a prominent educator in the state, and as superintendent of public instruction of Duval County, in which Jacksonville is located, had wide experience as an executive. His most recent position was secretary to the governor.

The organization of the department is shown in the

accompanying diagram. The state highway engineer, J. L. Cresap, has been in highway work for a number of years, and was connected with the early highway development in the state of Virginia. He has been in the Florida department since 1917 and has been state highway engineer since 1923. The state is divided into six divisions with a division engineer in charge of each and under each division there are project engineers in accordance with the necessities of the current development. Each division engineer also carries on his own maintenance operations. In the more important divisions there are maintenance engineers by name; in others one of the assistants has charge of maintenance without being so designated.

Plan Procedure—Procedure in construction of roads as reported by the state engineer is as follows: "After surveys have been made for proposed work to be done by the department, all notes and information are sent to the Tallahassee office where complete plans are prepared. In preparing plans it is necessary to plat and figure drainage areas, in order to determine the size of the structures necessary to adequately take care of the flow of water. Alignment and profile maps are prepared, on which a tentative grade line is drawn. The plans are then returned to the division engineer in general charge of the work to be done in order that he may make a further inspection of the survey in the field to determine the adequacy of the proposed plans. Such changes or alterations as are thought to be necessary are marked on these proposed plans, which are then returned to the Tallahassee office for completion. From this tentative grade line cross-sections are platted and figured in order to determine the amount of earth to be moved. After figuring the earthwork quantities, the grade line is arranged to eliminate waste as well as provide for sufficient material with which to make the roadbed.

Side drains along the highway as well as outlet ditches leading from culverts receive the same careful attention as any other part of the plan. Side drains are planned with true grades and even slopes in order that they may drain at all times and that ponds of water will not be left along the roadbed. Outlet ditches are cut true to grade and to as perfect alignment as the road itself, as proper drainage is one of the main factors in road construction and maintenance.

After the plans are made and all quantities figured, a detailed estimate is made of the cost of the section of road for which the plans were prepared.

Location—Because of the comparatively recent desire for high-class roads in Florida there is more real location work under way there than in the more developed states. Even today the number of roads, improved or unimproved, is less per square mile of territory than in most of the eastern states. There are few by-roads. Practically all of the roads are main roads extending from centers of population. There is little chance for one to get lost in traveling from one city to another or one town to another because, as a rule, there is only one road connecting the two. Indeed this condition is so marked that practically no direction signs are to be found on Florida roads; the traveler knows where he comes from and where he started for, which is assumed to be all the information he wants. With the growth of roads will have to come more signs and road marks.

All this means that the state has had to do considerable new location and a great deal of relocation. Work to date has been, as required by the law, upon the major routes laid out in the system and the program has been directed toward carrying through, as soon as possible, the main traveled routes of the state. These are, of course, the north and south routes down the east coast, a connecting line from the Jacksonville district to the lower west coast near Tampa, and a routing as complete as possible to the ridge country in the interior of the state. Below Lake Okeechobee in the Everglade country practically nothing has been done, although surveys are in progress on the so-called Tamiami Trail running west from Miami toward Marco on the gulf coast.

The roads completed and those now under construction are divided into two classes, one class designated as federal-aid and one designated as state-aid projects. The federal-aid projects are those constructed by the state in co-operation with the Bureau of Public Roads and the others are those constructed entirely with state

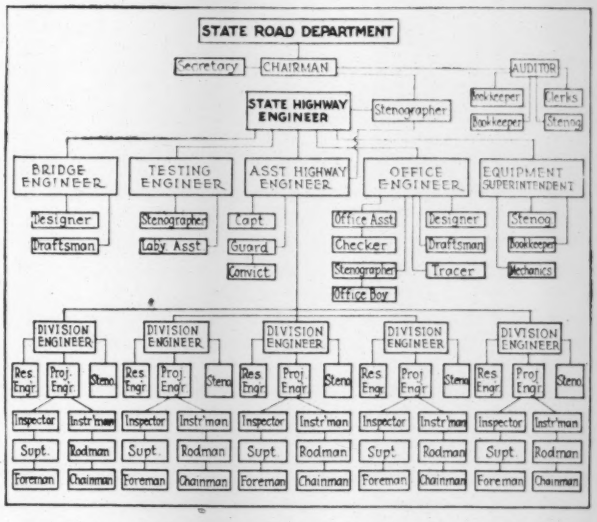


FIG. 1—ORGANIZATION CHART OF STATE ROAD DEPARTMENT OF FLORIDA

funds or with state and county funds. The specifications governing the work to be done by the state department are the same whether the road is federal-aid or state-aid.

Topography and Soil—In building all of the roads the Florida department has a peculiar condition to deal with in regard to the soil conditions of the state. Practically the whole state is a sand cover, more or less thick, over a coral or lime-rock base. Elevations along both coasts are very little above sea level and grades are rare. In the middle of the state, however, and in the panhandle to the west the topography is very broken, with many lakes among hills rising as high as 250 ft. above sea level. In the level sections, therefore, the roads have very little curvature and the grades are comparatively rare. In the center of the state, where the hills and lakes are, the grades and curves are those common to the rest of the country, that is, the curves are kept down to 8 deg. and the grades to 5 per cent.

Due to the peculiarities of the soil, however, for many years all hard roads in Florida were built with imported material. There is no hard rock in Florida. There is, however, the lime rock peculiar to the state. This is a rock generally of coral deposition which varies in composition in different localities, but is always very high in lime. It is found in practically all parts of the

state, though in the south section it is an outcrop or is generally at about mean sea level. It is soft in its natural condition and can readily be mined with stripping steam shovels. When exposed to the air, it gradually hardens and when crushed forms an excellent road base. In many sections, particularly in the southeastern, this crushed lime rock is used for the road almost as is.

The state department has successfully used this lime rock as the sub-base for a large part of the road system. In 1923, according to the report, 70 per cent of the mileage of the hard surface roads constructed by the department had the lime rock as a sub-base, and in 1924 this was increased to something over 90 per cent, showing that local materials have taken the place of

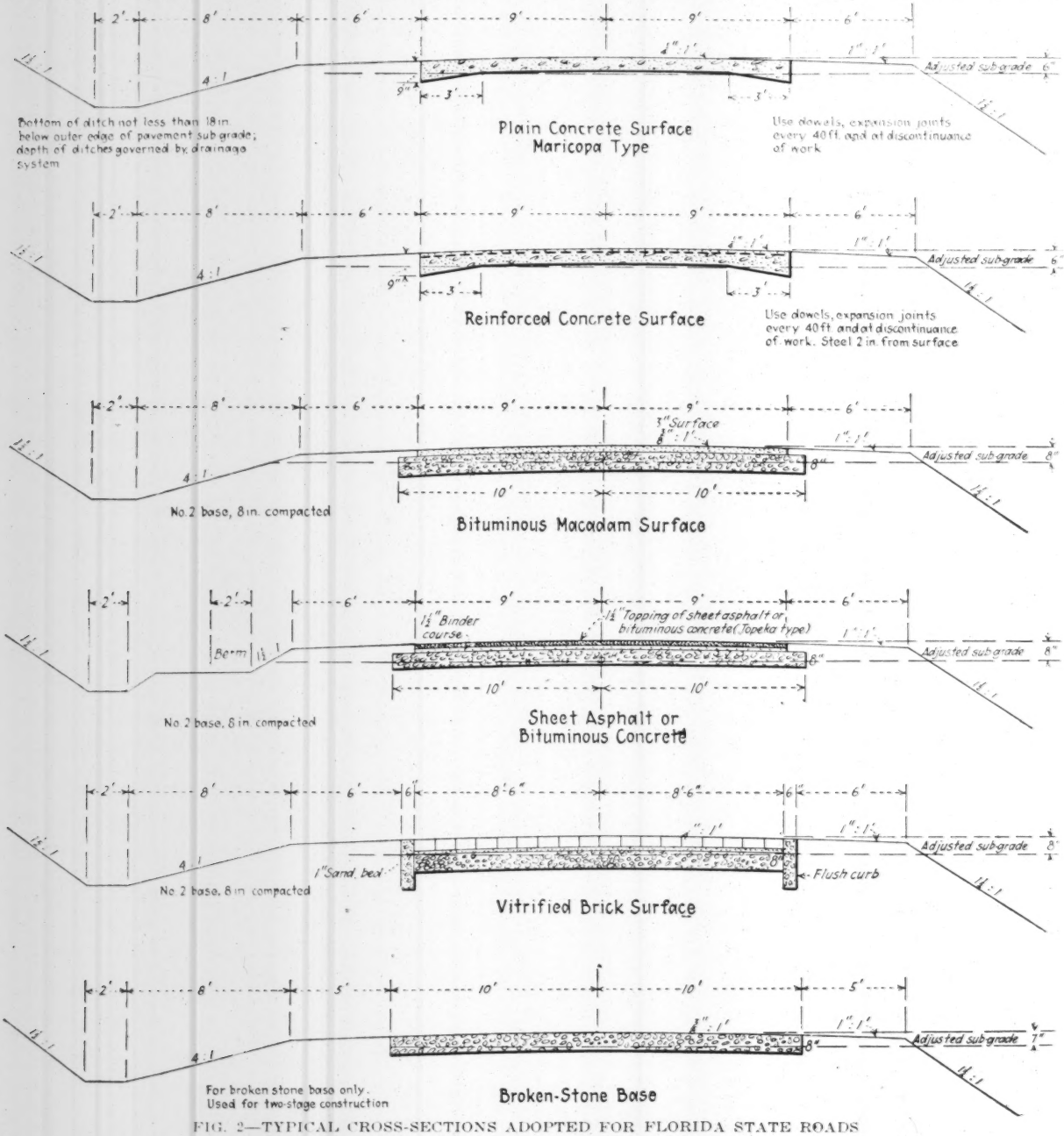

Bottom of ditch not less than 18 in. below outer edge of pavement sub-grade; depth of ditches governed by drainage system
Plain Concrete Surface
Maricopa Type
Use dowels, expansion joints every 40 ft. and at discontinuance of work
Adjusted sub-grade
Reinforced Concrete Surface
Use dowels, expansion joints every 40 ft. and at discontinuance of work. Steel 2 in. from surface
No. 2 base, 8 in. compacted
Bituminous Macadam Surface
3" Surface
Sheet Asphalt or Bituminous Concrete
½" Binder course
½" Topping of sheet asphalt or bituminous concrete (Topeka type)
Berm
Vitrified Brick Surface
1" Sand bed
Flush curb
For broken stone base only. Used for two-stage construction
Broken-Stone Base

FIG. 2—TYPICAL CROSS-SECTIONS ADOPTED FOR FLORIDA STATE ROADS

That is, a subgrade is roughly made on the sand, the lime rock is deposited in depths of about 9 to 11 in. and rolled to a thickness of 6 to 8 in. and in that condition forms the road itself.

However, this surface soon ruts and cuts under traffic so that the practice is to coat it with a black top of some sort, asphalt or tar. Many of the streets of Miami, for instance, are of this type and they are standing up excellently in service.

imported materials. This rock is used successfully as a base for brick, sheet asphalt, asphaltic concrete, bituminous macadam, and, in some of the minor roads, serves as an excellent pavement with a mere surface treatment as described.

The accompanying figure shows typical cross-sections of the roads as adopted by the department. The concrete and reinforced-concrete surfaces are laid directly on the subgrades. All the other types are on a lime-rock base

placed to a depth of 11 in. and rolled to a thickness of 8 in. Up to the first of January, 1925, the department had complete road projects aggregating 1,086 miles in length, which does not include projects under construction at that date. Of this total mileage of completed projects, 125 miles are of concrete, 52 miles of sheet asphalt on a lime-rock base, 23 miles of asphalt block, 72 miles of bituminous macadam, 12 miles of brick, 11 miles of bituminous concrete on 8-in. lime block, 328 miles rock base surface treated, 351 miles of sand clay—86 miles graded, and 37 miles of marl surfacing. This latter is a typical sand-clay road, of which a few are being built by the state.

Stage Construction—It has been the practice of the state to proceed with the construction of the roads in gradual stages and on account of the embargo on construction materials laid down in the fall of 1925 the program in the winter of 1925-26 is being especially directed toward this stage construction. By this method the roads first constructed are made either merely graded roads or sand-clay roads as the first step in the construction of the hard surface. It has been demonstrated that in order to get the best results in constructing hard surfaces the subgrade must be thoroughly seasoned and settled. The department therefore decided that the best plan in the building of a new road would be to construct first the sand-clay road, provided clay is accessible, and then after a year or two pave with some type of hard surface. This serves a double purpose. It gives the road a chance to settle and at the same time provides a reasonably good road for public use while the seasoning takes place.

Another class of stage construction has been adopted by the department when sufficient funds are not available to construct a finished road with a high type wearing surface such as sheet asphalt or asphaltic concrete. Here the department has constructed a standard grade with necessary drainage structures and on this has placed the 8-in. compacted lime-rock base, which is the standard of the department. Instead of putting what may be termed a permanent wearing surface on this base, a surface treatment of asphalt and stone or slag chips is applied. This treatment consists as a rule in a priming coat of light tar, which is allowed to stay from 30 to 90 days, and then is swept, and sealed with asphalt and slag chips. This makes a road which gives excellent service for a number of years and can later be surfaced with a better type with no loss to the state.

In some parts of Florida there will be found brick roads laid directly on a sand base. These have proved sometimes successful and sometimes not, but they are not approved by the state department for main highways unless laid on rock base with sand cushion.

Grading—Strange as it may seem to those who have believed that Florida is a flat plain, there is a great deal of excavation work in connection with a large mileage of the highways, particularly in the center of the state. Here it is reported that there is seldom a road graded that has not about 10,000 yd. to the mile excavation. The state does an excellent job with the shoulders and gutters. The gutters, as indicated in the cross-sections herewith, are wide and deep as required in a country of heavily concentrated rainfall. The shoulders are equally wide and are well kept. As soon as these shoulders are made, grass, generally Bermuda, is planted and in the Florida climate grows rapidly. Bids are called for sprigging these shoulders immediately after their construction. This sprigging consists in plowing three or four furrows along the shoulder and dropping sprigs of grass after the same general fashion as Bermuda is planted on the sides of Mississippi levees.

Maintenance—Maintenance of the roads is carried on under each of the division offices. In most of the divisions there is a patrol system of 10 to 12 miles with a section boss in charge. Where there are sand-clay roads, these divisions keep big outfits of graders and scrapers, but these have only to be used occasionally. One of the largest maintenance charges is the sodding of the shoulders and protecting them until the grass has gotten such a start as not to be destroyed by rain or by cattle which graze along the highways. On the sand-clay roads, grass shoulders are not so essential and practically all the cost for maintenance is in keeping the surface machined and dragged as well as keeping the drainage ditches open. Maintenance of the sand-clay roads also includes the adding of clay and sand in such quantities as will replace that part either blown away in dust or washed off by heavy rain.

The department carries on its maintenance work on a budget system and finds this works very well.

In connection with the maintenance, the state supports an equipment division with a warehouse for supplies near Gainsville. Here machine shops are equipped to do almost any class of repair work on any machinery operated in the construction and maintenance of roads. Most of this machinery is War Department surplus.

Bridges and Other Structures—The state is very heavily watered and therefore bridges are numerous; and on account of the excessive rainfall, with slow runoff due to the flat terrain, culverts are frequent. The department has adopted the concrete culvert as standard, some arched and some square sections. It is using corrugated iron culverts to carry cross roads over the side drains. In bridges the standard construction for permanent bridges is concrete, both the concrete pile and girder viaduct so familiar to travelers in Florida and also in a few cases long reinforced-concrete arch construction. For a number of the bridges, however, in the temporary locations or where money was not available creosoted pile and timber bridges have been built.

Grade Crossings—By an agreement between the various railroads in the state and the road department, signed in 1924, a co-operative program as to railroad grade crossing removal is under way. With the provision that no railroad shall be obligated to expend on crossing removal in any calendar year a sum in excess of one-fifth of one per cent of its total gross operating revenue derived from business in the state the year before, the road department can order grade crossing removal. In such removal the railroad pays roughly one-half the cost of the bridge proper and undertakes to maintain the structure. Under this arrangement twelve crossings have been either elevated or depressed on the line of state highways.

Convict Labor—Florida uses about 800 convicts on its road work. These are divided into separate camps throughout the state with 50 to 70 men in a camp, and are used to a considerable degree on preliminary grade work. According to the last report of the department, in the two years up to 1924 the convicts worked 497,943 days on the roads, which represents a money value of

approximately $1,244,000, based on present-day wages paid to free labor. The road department bears the cost of housing, feeding, clothing and guarding the prisoners making up the road force, which is 77c. per calendar day, or $1.07 per working day.

The prisoners are paid nothing for their labor. The efficiency of the convicts under the present system, according to the state department, shows a cost lower than free labor but it is not as low as it should be but the quality of the work is excellent.

Summarizing the work done by prisoners, there have been 320 miles of right-of-way cleared, 534 miles graded, 223 miles clay surfaced, 36 miles surface treated, 21 miles bituminous macadam, 9 miles concreted, and convict labor was used in the construction of 150 culverts and 10 bridges to date. The writer visited one of the convict camps near Tallahassee and was impressed with the cleanliness of the camp, the high morale of the prisoners, and the apparent excellence of the work which was being done. He was informed that there are occasional attempts at escape, but that taken by and large the department is completely satisfied with the convict labor method.

County Work—As stated, the counties of Florida are rushing into road improvement bonds at an unprecedented rate. Practically all the counties have county engineers and, with few exceptions, these men are excellently fitted for their duties. They are going ahead building roads in general accordance with the state requirements, and in some cases are setting higher standards. There is, however, a great deal of road work going on in some of the cheaper subdivisions that do not measure up to county or state standards.

Conclusions—So far as the present prospect goes, Florida is in an excellent way with its road program. It is operating under a pay-as-you-go principle with about $10,000,000 a year to spend. The department does not feel that more money than that can be expended in the state of Florida on roads today without bringing in contractors who are not fitted for the work or without endangering the possibility of getting material. With the present railway congestion in the state, it seems impossible that as much money as that can be spent in the current year on finished road work, so that the principal attention for the time at least will be toward primary grading. Fortunately, money can be profitably spent on this preliminary work.

The work that has been done so far is excellent. Most visitors to Florida today are doing their automobile traveling on the Dixie Highway, the popular name for Route 4 down the East Coast. For the greater part of the way this is not a state highway. It is a lime-rock base, light black-top road too narrow for the congested traffic it is now carrying and with no shoulders at all or at best of shifting sand. It is standing up remarkably under the load it is carrying but it gives a wrong impression of the typical Florida state road. The typical Florida road is amply wide for two vehicle travel, has fine safe shoulders and a wide right-of-way. The surface, generally of asphalt as the statistics above show, is smooth and remarkably free from the disturbing waves of the asphalt road of the north. In a fairly extensive experience of the roads of this country the writer has never ridden more comfortably or with more security at high speed than over the newer roads built by the state of Florida.

High Standard Brick Pavement for Illinois

New Twelve-Mile Road Calls for Concrete Base Construction Equivalent in Quality and Finish to Concrete Pavement

EXCEPTIONAL refinement of construction is being practiced in building some twelve miles of brick road in Knox County, Illinois, near Galesburg. The pavement is 3-in. lugless brick, with sand cushion and asphalt filler, on concrete base, and it is in the finish of the base and in the cushion construction that perfection is being exhibited particularly. The purpose is to prepare base and cushion so accurately that the brick wearing course will have to take care of no irregularities of surface or bearing. Structurally also the base is being made unusually strong and rigid. In brief the new highway is intended to be about the best brick road structure practicable within ordinary limits of rural trunk-line expenditure.

Base Construction—The new road is known as Type B-A (brick with asphalt filler) pavement. A cross-section is shown by Fig. 1. The design details to be observed are the 12-in. wide curbs; the center joint doweled across every 5 ft., and the continuous dowels or edge bars. The curbs, 4 in. deep, give the thickened edges which in the regular concrete pavement are secured by deepening the slab on the bottom. Virtually the distinctive features of the Illinois design for concrete pavement are carried into concrete base for brick pavement. The same mixture, 1:2:3½, of concrete is used in the base, and the requirements for materials, mixing, placing, finishing and curing are substantially those for concrete pavement. The same is true of placing center joint strips and center and edge dowel bars.

Of particular note among the construction requirements, however, are the finishing of the surface of the base and the construction of the sand cushion. The concrete between steel side forms is required to be struck off to exact crown but ½ in. high. It is then tamped and belted by finishing machine and tested by a 10-ft. straight-edge. If out of true more than ½ in. the surface is corrected by floating. Just before set there is a final belting and testing with straight-edge. The finished base has to be true in crown and show no variation exceeding ¼ in. from a 10-ft. straight-edge applied longitudinally at any point. In brief the base surface is constructed as truly as the surface of a concrete pavement and lacks only the polishing finish for sightliness which is given to the pavement.

A 1-in. sand cushion is called for. As soon as the sand is spread it is struck off by a templet curved to the crown and riding 1 in. high above the top of the base. Next the cushion is rolled with a steel hand roller weighing not less than 15 lb. per lineal inch. The bed is then struck off again and men with floats go over the sand near the curb and make it smooth and true. With a true base surface and a sand bed formed as described the expectation is to have a bedding uniformly deep and compacted, as a guard against shifting and unequal compression which may cause uneven settlement of the brick. The requirements for brick laying and joint filling conform to usual practice. The brick

are rolled longitudinally and diagonally with a 3- to 5-ton roller.

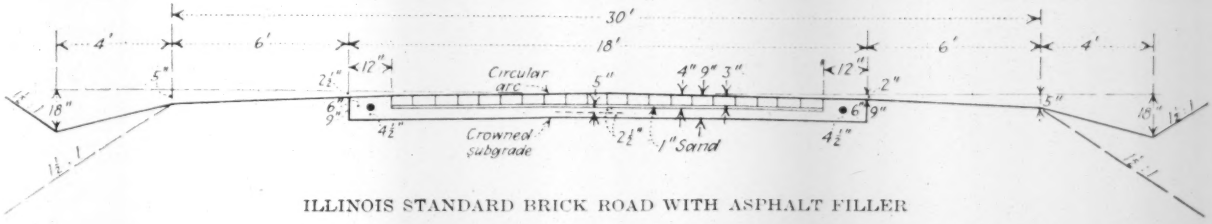
Three major points stand out in the base construction: (1) It is no less rigid and durable than the standard concrete pavement; (2) the surface is belted and floated to as true a profile as a concrete pavement and (3) the sand cushion is screeded and rolled to uniform depth and compactness.

Construction Methods—The road is being built in two sections, one 3.101 miles and the other 8.150 miles long. The location is in relatively flat prairie country requiring about 5,000 cu.yd. of grading a mile. Less than 1,000 cu.yd. of excavation calls for heavy machinery or blasting. Chief interest lies therefore in the subgrading and the concrete base construction. A blade grader, a 10-ton roller and a subgrader prepare the subgrade. There are 6 or 8 men in the subgrading gang. For the base construction proportioned batches are hauled in one-batch trucks to a 21-E paving mixer outfit. The loading plant, about two miles from the north end of the road, is on a siding and comprises stock piles, a 75-cu.yd. elevated steel bin in two equal compartments and a cement house with a loading platform at truck level. A stiff-leg and a 1-cu.yd. clamshell handle aggregate from cars to stock piles and elevated bin. At the bins underhung measuring hoppers charge the trucks as they drive underneath. The trucks go to the cement house and get their charge of cement by hand. The proportioning plant outfit is simple and a crew of 1 clamshell operator, 1 fireman, 2 car trimmers and 5 cement handlers does the work. About 28 trucks do the hauling; the longest haul has been about 6 miles, about half the distance over finished base.

A 21-E paver and a finishing machine, with a turntable, side and curb forms and small tools constitute the concreting outfit. A turntable man and a truck dumper, besides the driver, take care of charging the mixer. In laying base the slab without curb is first completed using however 9-in. side forms. As soon as the finishing machine has screeded, tamped and belted the slab for the full three trips and the slab has been straight-edged, the 4-in. inside curb forms are set with their tops about ¼ in. higher than the tops of the forms so that the curb top will have a transverse slant conforming to the crown profile. Two men wheeling back from the mixer fill the curb forms. This is done before the base concrete has begun to set; and to insure bond as well as face smoothness, two men puddle the curb concrete thoroughly. The regular slab finishers, three working, also finish the curb. Two men are required to set the 4-in. curb forms. The arrangement it is observed provides (1) construction of the main slab by finishing machine, and (2) construction of the curb integrally with the slab.

Including the curb builders the crew around the mixer is as follows: 1 turntable man, 1 truck dumper, 1 mixer operator, 1 finishing machine operator, 3 puddlers, 3 finishers, 2 placing center plate and bars, 2 wheelers on curb, 2 side form setters, 2 curb face form setters, 2 men spreading burlap and calcium chloride for curing, and 1 foreman. With this crew and outfit, runs of 750 to 850 ft. of base a day are regularly made. The best run as of Sept. 14, 1925, was 1,069 ft. in 11½ hours.

Bricklaying presents no unusual methods except in respect to the careful procedure on the sand cushion. An electric railway parallels the pavement and brick and bedding sand in railway cars are brought in on this line. The brick are unloaded by hand and stacked along the shoulder. Sand is shoveled from car to truck which delivers in piles on the base. About 7 men unload brick and two take care of the sand. Four men spread the sand for cushion. It is then struck off by a heavy screed riding on the curb and pulled by motor truck. Then comes the hand rolling and the smoothing up, particularly at the curbs, with trowels. A fine strike board pulled by hand then dresses the surface. About 2 men besides the 4 spreaders prepare the cushion. Two pavers and 8 helpers lay the brick, using a roll conveyor on wheels. About 6 men prepare and apply filler. A five-ton roller is used on the brick. A schedule of 1,000 ft. of brick a day has been set by the contractors.



ILLINOIS STANDARD BRICK ROAD WITH ASPHALT FILLER

Quantities and Prices—On both sections of road there are 55,082 cu.yd. of common excavation and 2,313 cu.yd. of borrow which is also soft earth excavation. The borrow and 11,108 cu.yd. of excavation was bid at 64c. and the remainder of the common excavation at 54c. Cement (30,940 bbl.) was furnished by the state at $2.09 a barrel and the bid on 543 cu.yd. of bridge and culvert concrete was $22.63 a cubic yard. The steel was bid at 4.9c. a pound. The price of $2.84 a square yard exclusive of cement on brick paving (118,949 sq.yd.) was notable.

The construction is under the direction of the Division of Highways, Frank T. Sheets, state highway engineer. The Central Engineering Co., Davenport, Iowa, is the contractor with F. H. Schmidt as general superintendent.

Continuous Increase in Number of Zoned Cities

The number of cities in the United States that had adopted zoning ordinances up to July 1, 1925, was 366, an increase of 46 cities and towns during the first half of 1925, according to information gathered and summarized by the Division of Building and Housing of the U. S. Department of Commerce. Of the 33 largest cities in the United States, with populations of 200,000 or more, all but six are now zoned. During the first half of 1925, five states, previously without statutory authorization of zoning, enacted zoning legislation. These were Arizona, Idaho, Maine, New Hampshire, and Utah. Four of these five states use the "Standard Act" of the Department of Commerce wholly or in part in drafting their laws.

Wearing Surfaces for Concrete Bridge Floor Slabs

Renewable Surface Desirable on Reinforced-Concrete Floors as Protection from Injury by Tire Chains

By E. F. Kelley
Highway Bridge Engineer, Bureau of Public Roads, Washington, D. C.

THAT concrete floor slabs should be protected by some type of wearing surface is now a fairly well established principle in highway bridge practice. The accelerated wear tests of concrete pavements conducted by the U. S. Bureau of Public Roads (see *Public Roads*, Vol. 5, No. 3, May, 1924) have given valuable information on the destructive effect of tire-chain traffic on concrete pavements. Bridge floors, like pavements, must resist such traffic effects and in addition they must support the traffic loads. A permanent bridge is built with the expectation that it will be much more durable than a highway pavement, which latter may be destroyed by traffic within a relatively short time. Therefore, in order that the load-carrying parts of the bridge floor may survive as long as the remainder of the structure, their surfaces should be protected from traffic wear.

What We Know of Traffic Wear—In the Arlington Farm wear tests of pavements, above mentioned, 75,000 trips of the test car equipped with solid rubber tires led to the conclusion that rubber-tired traffic, without impact, produces no material wear on the surface of a concrete pavement, at least as long as the mortar top remains intact. The solid tires used were new, and therefore produced no impact or abrasion such as might be produced by badly worn or broken tires. However, when the wheels of the machine were equipped with nonskid chains, only about 1,000 runs were necessary to wear away the mortar top which had resisted without appreciable damage over 75,000 runs of the same machine without chains; and 25,000 runs with chains wore a groove almost an inch deep in certain of the test sections.

Nearly all types of road surfaces being slippery to some degree when wet or icy, the use of non-skid chains is general, and in the northern states during the winter months practically continuous. Dense traffic, with the necessity for high speed and quick control, makes the use of chains essential in wet weather. With the increasing traffic density which we may expect, we may also expect an increasing use of chains until such time as the danger of skidding is eliminated by improvements in tire or pavement design. Other destructive agencies are steel tires (which are still used to some extent) and worn and broken tires (whose use is too common), both of which may produce destructive impact. In addition there is always the possibility that one of a number of causes may result in concrete having a low resistance to abrasion. In view of these facts it may be concluded that appreciable wear may be expected to develop in concrete pavements or slabs subjected to highway traffic.

In the case of concrete floor slabs of bridges, in addition to protection against the abrasive wear which may produce ruts it is particularly important that protection be provided for the cracks which frequently develop at construction joints and over supporting floor members. These may not be detrimental if waterproofed and protected, but if exposed to the impact of traffic they may, and probably will, eventually break down and ravel. Ordinary pavement crack maintenance with bituminous fillers can scarcely be depended upon to preserve the structural integrity of a concrete floor slab.

The wearing surfaces commonly used on concrete floors may be divided into the three general groups: Concrete, bituminous and block.

Concrete Wearing Surfaces—The concrete surfaces are of two types, those placed monolithically with the floor slab and those placed separately.

The monolithic surface is produced by increasing, by ¾ in. or more, the thickness of floor slab required to support the design loads. It has the advantage of cheapness and integrity so long as it does not wear. If crack maintenance does not prevent disintegration or if other wear develops, it has the two disadvantages that the danger point cannot be determined with accuracy, and that the wearing surface cannot be removed as a whole, so that repairs must add to the dead-load of the bridge. On bridges of limited load capacity this is an important consideration. The standard specifications of the American Association of State Highway Officials recognize the possibility that repairs may be necessary by requiring that bridges built with monolithic wearing surfaces shall be designed for an additional dead-load sufficient to provide for the future addition of a light bituminous surface. Some engineers provide for an even greater additional dead-load.

The separately placed concrete wearing surface has proven satisfactory when built of sufficient thickness. Pavements 4 in. thick at the center and 2½ in. thick at the edges are still in good condition after a number of years in service. The surface is cast in place after the floor slab has hardened, thus providing a definite construction joint between the two. In some cases the floor slab is mopped with bitumen prior to placing the pavement course in order to entirely eliminate bonding. These pavements are built both plain and reinforced with wire mesh. Only the ordinary paving crack maintenance is required. The advantage of this type is the separation of pavement from floor slab, which insures the easy removal of the former should it become necessary. On steel bridges it has the disadvantage of a somewhat greater weight than some of the other types of wearing surfaces.

Bituminous Surfaces—The bituminous wearing surfaces provide effective protection for concrete floors without adding undue weight to the structure and, in general, have proven satisfactory. As commonly used, they are either thin mat or carpet coats, or of regular pavement thickness of 2 in. or more. The mat coats, varying in thickness from ½ to ¾ in., are used for the protection of both timber and concrete floors and are particularly suited for use on light-traffic bridges where weight is an important consideration. They are composed of graded gravel or stone aggregate with either a tar or asphalt binder and are constructed by the penetration or pre-mixed methods. The use of a priming coat is usually considered necessary to insure adhesion to the sub-floor and the materials and construction operations must be carefully controlled if satisfactory results are to be obtained. The required maintenance is the only disadvantage of this type of surface but is not par-

ticularly high on well constructed mats under light traffic. The mat surfaces do not stand up well under heavy traffic and in such cases, especially if the mat is poorly constructed, the required maintenance may amount practically to complete renewal at frequent intervals.

The heavier bituminous pavements rank among the best of the wearing surfaces for concrete bridge floors when the items of cost, weight and performance are considered. The pavement may be any one of the various hot-mixed types or may be of natural rock asphalt or one of the artificial rock asphalts. The hot-mixed types, requiring considerable special equipment, are best adapted to large structures or to those so located that the wearing surface can be placed in connection with regular paving operations. Both the natural and artificial rock asphalts have proven satisfactory and have the advantage that they do not require heating and mixing on the job.

Block Pavements—The use of the block pavements on bridge floors is somewhat limited, due in part to their cost and in part, except in the case of wood blocks, to their weight, which may be an important item on some structures. Due to their light weight, wood block pavements are frequently used on the floors of movable bridges, but they are seldom used on the concrete floors of fixed spans since unsuccessful installations in the past have created considerable prejudice against them. Paving brick and asphalt blocks make excellent wearing surfaces for concrete floor slabs when cost and weight are not governing considerations. In one state, at least, the use of asphalt blocks is practically standard practice, but in general the block surfaces find their greatest use on city bridges.

Detailed construction specifications covering most of the wearing surfaces described above may be found in the standard bridge specifications of the American Association of State Highway Officials.

Tractor and Trailers for Refuse Collection in Chicago

Abstract of paper by W. J. Galligan, assistant superintendent of streets, Chicago, read at the Des Moines Convention of the American Society for Municipal Improvements.

MOTORIZATION of Chicago's refuse collection equipment was begun in 1923. During the preceding years the inadequacy of the city's method of collection in dilapidated wagons, the excessive cost of refuse removal by hired trucks, the increasing distance to dumps and advancing cost of operation led the City Council and Street Bureau officials to seek an improved system. They investigated the use of the tractor-and-trailer system in other cities. As they were convinced that this would give satisfactory service at less expense, they made appropriation for partial installation of this system. As these vehicles were for an entirely different activity from those previously used, the council departed from its established policy of standardization and authorized the purchase of one 5-ton truck from each of eight different companies, the prices ranging from $4,400 to $6,200 each. In this way the city was afforded opportunity for experimenting and deciding which truck was adapted for its needs. Likewise, in the selection of trailers, seven types were chosen. In fact all trailer manufacturers were invited to submit their wares.

Since the installation of the trial trailers, purchased during the summer of 1923, foremen of dumps, superintendents of collection and equipment, engineers and officials of the bureau have made careful investigation of their operation and efficiency as contrasted with the old method of team and motor truck haul. Reports from all are favorable to the tractor-and-trailer-system. Their investigations have convinced them that two types of trailers are adapted to Chicago's needs. In accord with this finding, 160 trailers of the two makes selected were purchased at a cost of $248,865.

As no appropriation was made for the purchase of tractor trucks and the city was hiring trucks at the rate of $32.50 per day, a truck company proposed furnishing them on a rental plan. When an amount equal to the cost price of the truck had been paid, the equipment would become the property of the city of Chicago. The plan was accepted and 25 tractor trucks were placed in service in August, 1924, to be paid for on the deferred payment plan of $400 per month for each truck, payments to be continued until $6,100 per truck was reached.

The initial installation of the tractor-and-trailer system was made in 14 of the 50 wards into which the city is divided. Four of the wards were selected because their respective ash-and-refuse teams were able to make only one load a day, the dumps available for disposal being from 8 to 9 miles distant. This made the cost of collection almost prohibitive. In the case of two wards chosen for experimental purposes on short hauls the distances to their respective dumps were 3 and 5 miles. In the six wards there are eight tractor-and-trailer units, one tractor and three trailers in active operation forming a unit or train. To each unit there are three, and in certain wards six trailers in reserve in order that collections may not be interrupted while tractor and train are in transition.

The tractor-trailer trains make from five to six trips on the 3-mile haul, four trips on the 5-mile, and three on the 8- or 9-mile haul, traveling in the last instance a total of 48 to 54 miles daily. The tractor picks up the trailers from their collection districts or from a central point to which the trailers have been brought for that purpose. Where conditions permit, the tractor hauls the trailers into the dump, but where this is impossible by reason of bog-like condition, "crawlers" bring them in. The tractors are manned by a driver and helper and operate in specific districts. Three to five loads are collected daily. The trailers have a water-level capacity of 4½ cu.yd. The loads are heaped and receive a credit of 6 cu.yd. at the dump. The engineers state that they carry more nearly 7 than 6 cubic yards.

Based upon the test of the past year with 8 tractors and 81 trailers the city officials and engineers estimate that 142 tractors and 1,020 trailers are needed to cover the area within the city limits. The cost of these vehicles is placed at $2,342,000. Supplementing them the city would still employ 452 teams to collect from the unimproved alleys of the city. With that equipment a large saving would be effected.

Last year the collection of ashes and refuse cost $2,570,190 and the hauling of garbage, $638,125, a total of $3,208,313. It is estimated that the same service in quantity but considerably better in character could have been rendered by the tractors and trailers for $2,490,810, thereby effecting a saving of $717,503. From this estimated annual saving alone, all the tractors and trailers required could be paid for in about three years.

Joint Garbage Disposal in New Jersey

Municipal co-operation in the transportation of garbage after collection with the idea that disposal could be effected at some common point was suggested in a report made by the Committee on Garbage Disposal of the New Jersey Sanitary Association at the recent meeting of that organization. The plan might be particularly suitable, the committee believed, "where water transportation through populous districts is available," such as those in the Passaic Valley. The committee suggested that a district might be created and that possibly the city of Newark might erect a disposal plant at which the garbage and refuse of other communities in the valley might be disposed of after transportation by water from loading docks at various points on the Passaic River. The chairman of the committee is Morris R. Sherrerd, consulting engineer, Department of Streets and Public Improvements, Newark, N. J.

7¾-Mile Cascade Tunnel for the Great Northern Ry.

Contract Let for Great Tunnel to Lower Summit Elevation, Improve Location and Eliminate Snow Troubles

A NOTABLE event in the engineering history of 1925 is the award of a contract for a rock tunnel 7¾ miles long on a relocation of line to improve the crossing of the Cascade Range of the Rocky Mountains by the Great Northern Ry. This great tunnel, about 100 miles east of Seattle, will not only lower the summit elevation and reduce the distance and curvature, but it will also eliminate a mountain section subject to severe snow troubles. A comparison of the present and new lines is shown in Fig. 1 and the accompanying table, while the general situation is indicated by Fig. 2.

The Great Northern Ry. first crossed the Cascade Range by an open switchback line over the Stevens Pass, in 1892, but the present Cascade Tunnel, eliminating the switchbacks, was completed in 1900 (see *Engineer-News* of May 18, 1893, and May 10, 1900). Electric operation of this tunnel was introduced in 1909, and preliminary work is now in progress for the electrification of a 24-mile stretch of line which will include the new tunnel.

On this relocation, the tunnel will give practically a direct line between Berne and Scenic, instead of the present circuitous and steep route by way of Tye. Between Tye and Scenic snowsheds have been built and extended continually until with the work done in 1916 more than 76 per cent of the stretch was so protected (see *Engineering News*, June 4, 1914).

The present line crosses the divide at an elevation

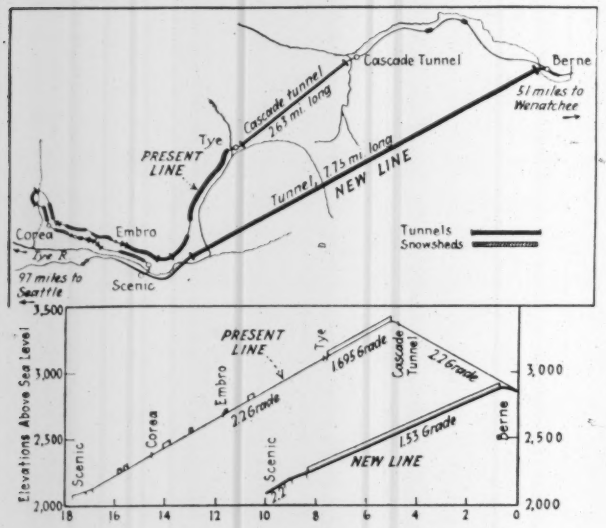


FIG. 1—NEW AND OLD CASCADE LINE; GREAT NORTHERN RY.

of 3,385 ft. above sea level. It has steep grades, numerous and sharp curves, numerous snowsheds and several tunnels, the longest of which—known as the Cascade Tunnel—is 13,873 ft. long. On account of the heavy snowfall, reaching a maximum of 410 in. at Berne and 670 in. at the Cascade Tunnel in a single season, it is an expensive line to operate and to keep open. In addition to the blocking of traffic by snow there have been occasional accidents due to great snowslides, as in April, 1910, when trains were swept down the mountain and more than 80 lives were lost. Several minor changes in location have been made from time to time to improve the original location.

RELOCATION ON CASCADE RANGE, GREAT NORTHERN RY.

	Present Line	New Line	Difference
Length, miles	17.68	10.01	7.67
Max. curve	10 deg.	5 deg.	5 deg.
Total curvature	2,169 deg.	219 deg.	1,950 deg.
Max. grade	2.2 per cent	2.2 per cent	none
Tunnel grade	1.695 per cent	1.53 per cent	0.165 per cent
Summit elevation	3,385 ft.	2,879 ft.	506 ft.
Total rise, westward	522 ft.	26 ft.	506 ft.
Total fall, westward	1,299 ft.	793 ft.	506 ft.
Snowsheds, total miles	6.04	none	6.04
Bridges, total miles	0.23	0.04	0.19
Tunnels, miles	3.66	7.75	4.09

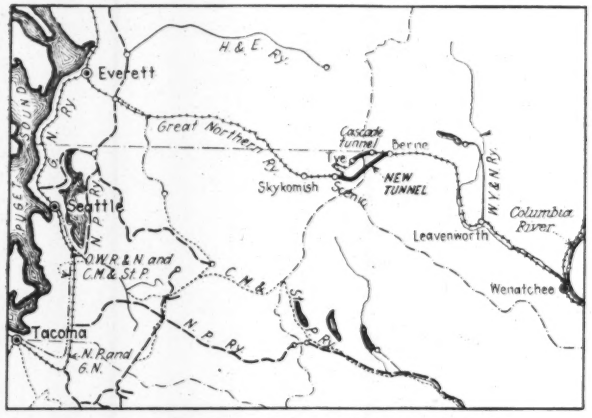


FIG. 2—GREAT NORTHERN RY. AND NEW CASCADE TUNNEL

During the past twelve years, however, many studies have been made for an entire relocation to secure a line at a lower elevation which would avoid much of the expense and trouble due to snow conditions. Such a line would involve a very long tunnel. These studies were begun in 1912 under Ralph Budd, then chief engineer and now president of the Great Northern Ry. The increasing importance of having a thoroughly dependable line, together with the fact that additional snowsheds were needed to assist in keeping the present line open, while heavy repairs are requird annually on the existing tunnels and snowsheds, brought expenditures to a point where interest on investment and operating costs of a new line would show a substantial saving as compared with the present line. As a result of these studies and investigations the Board of Directors in November, 1925, authorized the construction of the new line.

This relocation will shorten the distance, will eliminate nearly six circles of curvature, and by crossing the range at a considerably lower elevation it will also eliminate much of the snow trouble. Its main feature will be the new Cascade Tunnel, 7.75 miles long, with an estimated cost approximately $10,000,000. It will be a single-track bore, 16 ft. wide and with a height of 22 ft. above head of rail.

The contract for the tunnel was let early in December, and work was commenced at once on the construction of camp sites and tote roads. The contract was let to the A. Guthrie Co., Inc., of St. Paul, Minn. The engineering forces are in direct charge of Colonel F. Mears, assistant chief engineer, Great Northern Ry., at Seattle, Wash., reporting to J. R. W. Davis, chief engineer, at St. Paul.

From Job and Office

Hints That Cut Cost and Time For the Contractor and the Engineer

Full Detour Data at Site Essential

By B. H. Piepmeier
Chief Engineer, Missouri State Highway Commission, Jefferson City, Mo.

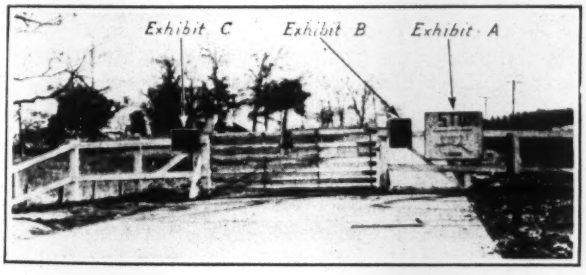
DETOURS are the bane of the contractor, engineer and motorist. There appears to be no economical way to avoid them. In a few instances side roads along the construction work may be provided but such provisions usually result in delays, trouble and disasters. Building one-half of the road at a time is usually unsatisfactory to the contractor and to the public. Though in extreme cases this sort of construction is justifiable, the contractor must plan his work to meet such conditions.

The customary detour and the one most commonly used in the central states is to divert traffic over a different road. This may necessitate the use of an entirely different route between terminal points as well as the shortest detour around the work to be avoided. In either case, the information concerning the detour must be spread in such a way that the public will get the facts when most needed.

The average motorist travels his predetermined course with little or no information concerning roads or detours. He seldom has an up-to-date map or complete detour information even though it is available. The chief problem, therefore confronting the engineer and contractor is to get the proper detour information to the traveler at the time when he needs it the most.

The motorist wants full information when he actually comes to a detour. In most cases he will take time then to read the information. It is at this point he needs facts. The engineer and contractor should spare no effort in providing facts at the detour point.

In the first place a contractor should provide a barricade or fence that looks as if it was intended to keep travel off the road. The fence or barricade must then



BARRICADE THAT REALLY DETOURS TRAFFIC
Note the semi-permanent type of construction that reaches entirely across the road. Exhibit A is a vicinity map. Exhibits C and B are shown in the opposite column.

be supplemented with full detour information. The word "Detour" or "Bridge Out" or "Road Closed" is not sufficient. The average traveler will often take a chance and pass up these signs with the hope that he will make it through. If the barricade sign gives the full length of the detour, the directions, towns on it, course, etc., or provides a rough sketch map of the course of the detour, the traveler will follow it with little complaint if it is well marked and reasonably well maintained.

Full detour information at the point of detour is

TYPES OF DETOUR SIGN USED IN MISSOURI
Exhibit D at upper left, Exhibit B at upper right, Exhibit E lower left and Exhibit C at lower right. Exhibits B and C are shown in figure in left-hand column.

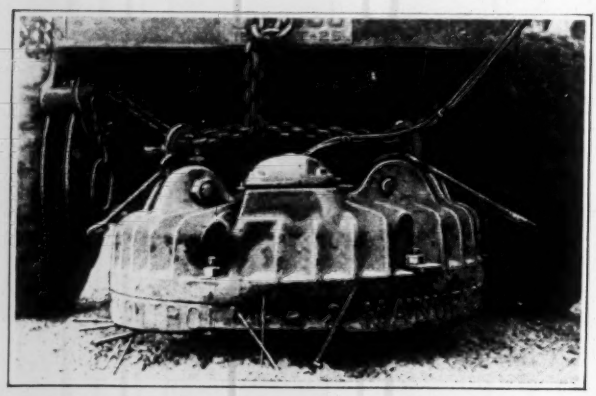
worth to the traveler much more than the published information which but few read or have in their possession.

Magnet on Truck Picks Scrap From Western Gravel Road

AS A result of the success a mining company in Idaho had in ridding a gravel road of pieces of old metal by use of a heavy magnet, the Idaho State Highway Department secured use of the equipment to "clean" part of the Yellowstone Trail that had been causing motorists a great amount of trouble. The road was cleaned by a heavy lifting magnet suspended from the rear of a 5-ton truck about 4 in. above the road surface. Electric current was supplied to the magnet by 72 cells of regular locomotive-type storage batteries.

In sweeping back and forth across five miles of road in its first trial, the magnet picked up 150 lb. of nails, bolts, wire and scrap iron, all of which constituted a severe menace to automobilists. In cleaning a portion of the Yellowstone Trail three trips were made during

which time 603 lb. of nails and scrap iron were extracted from the road surface. Much of this was invisible to the naked eye.



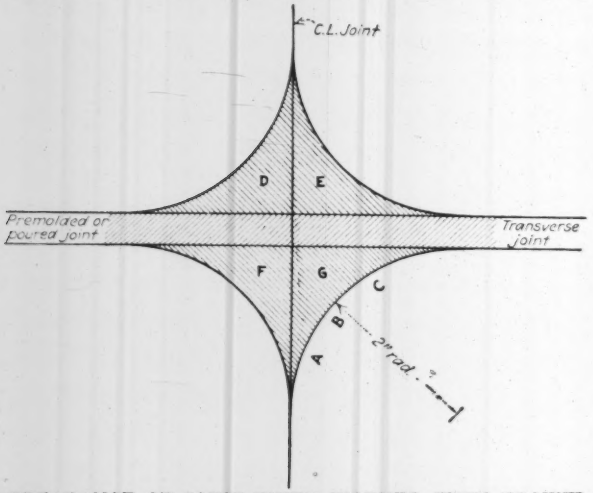
HEAVY MAGNET ATTACHED TO 5-TON TRUCK

The information herein contained was furnished by the Electric Controller & Manufacturing Co., whose magnet was used in the experiment.

Safeguarding Concrete Road Slab Corners from Spalling

By Frank E. Harley
Assistant Civil Engineer, New Jersey State Highway Commission, Paterson, N. J.

IN THE usual intersection of transverse and center-line joints in concrete pavement, the sharp corners of the slabs at the center frequently spall. This spalling continues under traffic until there is a badly spalled area of a half foot square or more. In order to prevent this, a 2-in. radius trowel is used to finish the corners



APPEARANCE OF JOINT WHEN WORKED WITH TROWEL

as shown in sketch. This trowel is worked up or down for a depth of four or five inches in each corner, when finishing the joint, and finally the top of each corner as at *ABC* in the accompanying figure is slightly rounded off. When the concrete has set, the spaces *DEFG* are filled up with a bitumen.

In examining a number of these joints after a year's traffic had passed over them, very few were found with any appreciable spall, at this usual point of weakness.

From Job and Office

Hints that Cut Cost and Time

Cost Data and Procedure in Placing Slag Base Course

By O. W. Gatchell
Sanford, North Carolina

SOME interesting data have been made available on road contractor's plant for handling and placing bank slag on macadam base course work. Local deposits from which the slag was obtained are widely distributed through the Hocking Valley in Ohio, being the furnace refuse from iron ore reduction works operated in the region several decades ago. The state highway department has encouraged the local use of this slag on base courses for bituminous macadam pavements when the material is properly cleaned and graded.

Operations required to get the slag out included: excavating from the bank, hoisting up the tipple, screening and loading. Practical considerations limited the type of plant used to a relatively cheap, flexible layout, since the quantity and quality of slag in any deposit could not be accurately determined until the bank had been opened. On the 5-mile road job in question it was expected that more than one bank would be opened, hence the trestle bents were framed and bolted to permit reuse.

Rather than install heavy crushing equipment at the pit, the contractor chose to have the slag graded by hand napping after the material had been dumped on the road. Slag was excavated at the bank by a ¾-yd. steam shovel loading into 3-yd. bottom-dump cars. Loaded cars were pulled by a gas hoist up the tipple which was laid on a 7 in 24 slope. The slag, after being dumped from the car, passed over a coal screen, made of ⅜-in. bars laid at a 40-deg. angle on 3-in. centers, into a bin from which trucks and wagons were loaded by means of a drop pan and winch. A second bin directly under the screen collected the earth and refuse material screened out. Steep side slopes were necessary on both bins and dump cars as the slag had a tendency to bunch and wedge fast especially when wet.

A combination truck and wagon haul was used to carry the slag to the grade. Wagons were particularly useful on short hauls and moreover did not damage the first course when hauling for the second base course. After being dumped on the grade, slag was spread out to a loose depth of 7 in., napped by hand and rolled to a compacted depth of 4½ in. Standard screenings from modern blast furnaces were used for filling the surface voids and otherwise the practice followed the usual methods for constructing water-bound base courses.

The fullest output possible with the plant described could not be obtained every day due to haul conditions. Daily progress on a 16-ft. roadway averaged from 400 to 800 lin.ft. of 4½-in. base course. The operating crew at the slag pit included a shovelman, fireman, switchman, hoist-runner, who also cleaned screen, and one loader. Three 3-ton trucks and five wagons, one of which hauled only screen refuse, comprised the hauling

From Job and Office

For Contractor and Engineer

equipment. The grade crew consisted of six nappers and a rollerman. Pit tracks, dump cars, tipple, hoist and bins cost $1,500. On a basis of 1,000 sq.yd. output of rolled base course per day, the cost of placing slag (4½-in. course) was as follows:

	Dollars per Day	Cents per Sq.Yd.
Wages of pit and tipple crew	22	2.2
Overhead and operating supplies for shovel	18	1.8
Charge for tipple equipment	..	2.0
Royalty on slag	..	1.0
Hauling slag to grade	100	10.0
Grade crew	28	2.8
Overhead and operating supplies for roller	10	1.0
Standby charge—all crews	20	2.0
Contractor's supervision and overhead	22	2.2
Total cost, excluding cost of filler screening and water, 4½-in. slag base course in place		25 cents

J. O. Petrie, of Logan, Ohio, was contractor on the above work.

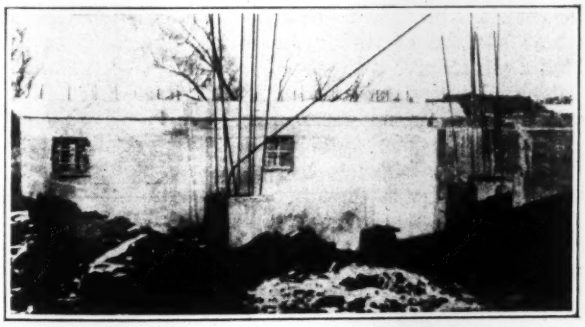
Supporting Pavement Slabs on Bridge Approach Fills

By F. M. Balsley

Construction Engineer, Wisconsin Highway Commission, Madison, Wis.

SETTLEMENT of paving slabs on embankments adjacent to bridges has proven a source of trouble and expense to every highway department. We provide a 4-in. rest in the floor of concrete bridges to support the ends of the pavement slabs on adjacent embankments. This does away with settlement at the point of connection with the bridge floor, but at these points only. Although our paving section for approaches to bridges carries a large amount of reinforcement, the ultimate settlement of the embankment permits the slab to bend enough to make the depression a serious inconvenience to traffic.

In 1924 we built a deck-girder bridge at Hubbleton,



COLUMNS SUPPORT BRIDGE APPROACH SLAB ON FILL

Wisconsin, consisting of six 50-ft. spans. The abutments were of the "U" type with the curbs cast monolithic with the wings and in line with the curb on the spans. As construction proceeded it was noted that, with the approach slabs covering the entire width between the wing curbs, there was no possible chance to secure access to the underside of the slabs to jack up or fill under them if settlement took place. The curbs on the wings were cantilevered sufficiently to bring them in line with the curbs on the spans, and any appreciable settlement of the approach slabs would not only present an unsightly appearance, but allow storm water to run off the edge of the slabs on to the fill underneath.

The problem was finally solved by supporting the pavement between the wings by concrete columns and girders, which carry the entire weight of the approach slab without relying on the embankment. After the columns and girders had been poured, the fill was placed flush with the top of the girders and thoroughly compacted. The slab reinforcement was placed in the same manner as though a bridge floor were being built. The thickness of the slab was 21 in. Due to the soft nature of the fill and the weight of the concrete, settlement occurred while the slab was being poured, so that difficulty was experienced in keeping the top of the slab up to grade. A screed was used to strike off the concrete and as settlement occurred the low places were filled with concrete until settlement ceased. This structure has now been in service about a year and the approach slabs are still in their original position.

On two other bridges we have used steel I-beams salvaged from the old bridges to support the approach pavement slabs. These have been spaced 2 ft. 3 in. on centers, supported at one end in rests in the abutment, and at the midpoint and outer end on shallow concrete walls. The fill was made between and around these I-beams to a point within 1 in. of the top of the upper flanges. After the fill was thoroughly compacted, a flared trench was cut each side of the beams to a point 4 in. below the lower flange. The beams were then wrapped with lightweight woven-wire fencing, and the concrete was poured monolithic from the lower flange of the I-beams to the finished surface of the slab. Reinforcement consisted of two lines of deformed bars ½ in. square between each pair of I-beams longitudinally, and ½-in. square deformed bars at 6-in. centers transversely. Encasing the I-beams in concrete precludes the possibility of their rusting and makes an improvement of this nature last as long as the slab. Both of these jobs are standing up well and show no signs of settlement or break in the slabs.

We are now designing bridges on projects soon to be paved in such a way as to make of the approach slab support part of the structure, to be built at the same time as the rest of the bridge. This simplifies both design and construction and is more economical than using column construction after the bridge is completed.

Superelevation on Pavement Curves Figured by Simple Method

By R. T. Brown

Lee, Murray, Palmer & Brown, Consulting Engineers, York, South Carolina

HAVING found by experience that the average resident engineer frequently is called upon to lay out a piece of work and finds that he has left his formulas in the office we have devised some simple means of field work, which include the laying out of a superelevated curve on a paved roadway.

We adopted a minimum superelevation of 0.3 ft. and the formula E (in tenths) $= 2D - 1$ E being the maxi-

mum superelevation and D the degree of curvature, which gives for curves up to and including 6-deg. curves the following values, which very closely approximate the values for superelevation derived from the state highway formula for 30 m.p.h. speeds:

Deg. Curvature	Superelevation in Ft.
1	0.3
2	0.3
3	0.5
4	0.7
5	0.9
6	1.1
Above 6	1.1

This gives so closely the theoretical superelevation that we have used it throughout, and find the results entirely satisfactory.

The outer form is raised and the crown of the road retained up to and including a 5-deg. curve. For curves sharper than 5 deg. the crown is taken out, beginning at a point 100 ft. from the ends of the curve, so that the maximum superelevation provides an inclined plane throughout the length of the curve.

The approach to full superelevation and the run off back to tangent grade have much to do with the appearance of the road. Too sudden rise gives the impression of a dip in the grade at the beginning of the rise and a hump at the point of maximum superelevation. Some highway departments specify the rate of rise and point at which full superelevation is to be attained, and leave it to the inspector and form setters to put in by eye suitable vertical curves. We have found that when this is done there is a tendency to take out the apparent dip in the grade, which shows up more conspicuously in the forms than in the finished pavement with shoulders completed, with the result that the run off is carried too far. In other cases the forms are not lowered sufficiently at the summit, and an obvious hump is the result. We have worked out a satisfactory method of handling the approach and run off, which involves little calculation and is easily remembered.

For the points of full superelevation we take the nearest even + 5 station to the ends of the curve. For example: If the curve begins at Sta. 87 + 43.2, we reach full superelevation at 87 + 40 or 87 + 45, as may be most convenient. Forms are usually in 10-ft. lengths, so it is convenient to figure the rise on 10-ft. sections. However, the joints seldom coincide with the figured points, nor is that necessary. It is not even necessary to set stakes at each 10-ft. point after a few curves have been put in and the inspector and form setter get familiar with the method.

To provide gradual transition in the grade, the increments of rise used are: In the first 10 ft., 0.01 ft.; in the second 10 ft., 0.02; third 10 ft., 0.03; fourth 10 ft., 0.04; giving a total of 0.10 in the first 40 ft. The order is reversed for the last 40 ft. of the approach, the increment for the fourth 10 ft. from the point of maximum superelevation being 0.04 ft., for the third section 0.03, for the second and end sections 0.02 and 0.01 ft., respectively. This gives a total constant increment of 0.2 ft. rise, and a constant length of 40 ft. for all curves. The necessary additional rise is secured at the rate of 0.05 ft. for each intermediate 10-ft. section.

Thus, for curves up to 2 deg. the superelevation is 0.3 ft. and the approach length and rise are:

40 ft. @ 0.01, 0.02, 0.03, 0.04	=	0.10
20 ft. @ 0.05 per 10 ft.	=	0.10
40 ft. as above	=	0.10
100 ft. length of appreach		0.30 rise

For 5-deg. curve the length and rise are:

40 ft. transition	0.10 ft.
140 ft. @ 0.05 per 10 ft.	0.70 ft.
40 ft. transition	0.10 ft.
220 ft. total approach	0.90 total rise

By this method the increment to be added to profile grade at any point on the approach and run off can readily be figured mentally, and it is only necessary to drive a stake on grade at the beginning of the approach transition and at the end of the run off, and at any convenient intervals up to the points of maximum superelevation.

From Job and Office

Hints that Cut Cost and Time

Clayey Aggregates Successfully Used in Georgia Asphalt Pavements

By W. R. Neel

State Highway Engineer, East Point, Ga.

In order to take advantage of the large deposits of native sand, stone, gravel, sand-clay, clay-gravel, etc., existing throughout the state of Georgia, a contractor of Atlanta has devised an asphalt mixing plant which successfully mixes these aggregates with asphalt without the balling up which has heretofore made use of clayey aggregates in asphalt-paving practically impossible. Now, by the Finley method, which the highway department is using, any material which ordinarily is used in waterbound macadam paving will serve as the total aggregate and filler for an asphaltic concrete by simply replacing the water content with asphalt. Encrustations on aggregate are impregnated with the asphalt and in no way impair the value of such material.

The feature of the Finley paving plant is the mixing unit or drum marked B on the accompanying photograph. This is a hollow cylinder with convex ends mounted with the axis of the cylinder in a horizontal position and designed to rotate on that axis. The interior surface of this cylinder is fitted with mixing blades which give a three-way movement to the aggregates and cascade them from the top of the drum over and through the asphalt nozzles.

Under the Finley method when dust or filler is used it is gradually added to the hot aggregates in the elevator E and so is distributed through the charge in the hopper A, where it acquires considerable heat before placing in the drum. In the mixer the charge is mixed dry for 30 to 60 sec., thus thoroughly distributing the filler so that it is fully as hot as the aggregates before admitting the spray of asphalt. Any desired amount of filler may thus be used without waste and without lumping or balling, and each particle of filler will have its individual coat of asphalt.

The drum is charged and discharged through the door D, which is centrally located in the shell of the cylinder. The heated and weighed aggregates are elevated through E and stored in the charging hopper A. A single charge weighs from two to eight tons, depending on the size of the plant. A charge fills the drum about half full.

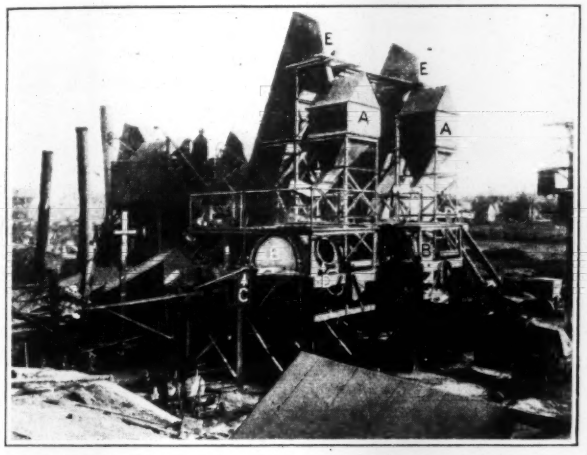
The plant in the photograph mixes a minimum of four

From Job and Office

For Contractor and Engineer

tons of sheet asphalt or five tons of black base or binder per batch. Portable plants are designed up to a capacity of four tons per batch.

After the dry hot aggregates are placed in the drum, the airtight door is closed and the mixer rotated until the mix is homogeneous as to screen size. The hot asphalt is then forced under air pressure through the hollow axis of the drum, upward through a fixed horizontal header and through conical spray nozzles, thus filling the upper part of the drum with a fine spray of atomized asphalt. The aggregates constantly cascading through this spray are completely coated. The



ASPHALT PAVING PLANT USES CLAY AGGREGATE

air pressure within the drum is then raised to about 50 lb. per sq.in., while the mixing continues. The asphalt is thus forced into all re-entrant facets on the surface of the aggregate, through all excrustations, and into the surface itself, preventing the possibility of future damage from water. The excess pressure is then released and the heated mixture is ready to dump and haul to the point of use.

The large size of batch simplifies all weighing, gives uniform temperature, prevents spot-burning, reduces truck time loss, and, without decreasing the output, allows each batch to be mixed at least five times as long as by other methods.

Delaware Speeds Up Execution of Road Contracts by Time Charge

By W. W. Mack

Acting Chief Engineer, Delaware State Highway Department
Dover, Delaware

An article which was published in *Engineering News-Record*, Dec. 18, 1924, p. 989, on the use of a time charge in construction contracts seemed to the Delaware State Highway Department to suggest a plan worth a trial. Accordingly, when the 1925 revision of the Delaware State Highway Specifications was made the following provisions were incorporated:

A. INSTRUCTION TO BIDDERS

Time Charge—Time is an essential element in this contract, and the work shall be completed by.....192.. As the prosecution of the work will incommode the public, obstruct traffic, and interfere with business, it is important that the work be pressed vigorously to completion. Also the cost to the Department of the administration of the contract, including inspection, engineering and supervision will be increased or decreased as the time occupied in the work is lengthened or shortened. Therefore a time charge of .....dollars ($.....) per day (excluding Sundays) will be made against the contractor and the amount of it will be deducted from the contract price as payments are made. This charge will be commenced on the date the contract is executed and continue until the completion of the work. Each bidder should include in his estimate of the work a sum equal to the amount derived by multiplying said time charge by the number of days within which he estimates he can complete the work. The time charge will be suspended during the period of any delay that may be caused by the Department, either through changes in plans, or through ordering suspension of the work for any reason.

B. EXTENSION OF TIME

If any delay is caused to the contractor by specific orders of the engineer to stop work, or by the failure of the engineer to provide necessary instructions for carrying on the work, or to provide necessary right-of-way, such delay will entitle the contractor to an equivalent extension of time, and the suspension of the time charge only. When extra or additional work is ordered by the engineer the contractor will be allowed a suspension of the time charge equal to one day for each ..... hundred dollars of the cost of such extra or additional work.

C. PAYMENTS

Monthly and final payments will also be reduced by the amount of the time charge for the period covered.

This time charge, varying from $10 to $30 per day, according to the individual job, has now been used on about 30 contracts with results that have been very satisfactory.

The difference in the progress made by small and large contractors alike has been marked and has been commented upon by all our engineers and inspectors. This has been particularly noticeable in the early and late stages of the work when the greatest delays usually occur. No objections to the time charge have been made by contractors and none has been met in its operation.

The advantages as so far developed, are: (1) Marked speeding up of work in the preliminary and final stages of construction, with a corresponding shortening of the time a road has to be closed; (2) the opportunity given the competent contractor with adequate plant to reflect, in his bid, his ability to produce results; (3) the elimination of disputes over the amount or legality of liquidated damages and the bonus and penalty clauses formerly used.

The argument will be advanced that the penalty or liquidated damage clause will speed up the work equally well, but the fact remains that every contractor feels confident of finishing his work on time when he signs the contract and seldom thinks of the penalty clause until the time limit is reached, whereas the time charge is in his mind from the very start.

The Delaware State Highway Department has completed practically 50 per cent more work during 1925 than was estimated and not a little of the credit for this increase in highway mileage is being given to the use of the time charge.

Letters to the Editor

This department aims to be a forum for the discussion of the views of engineers and contractors. The range of interest should be as wide as possible. Contributors are, therefore, asked to make their letters short.

Structural Steelwork Defended

Sir—Referring to the editorial note entitled "Gambling in Buildings" in your issue of Dec. 24, 1925, p. 1019, there is no doubt that a certain amount of poor building has been done in New York City. The fact is, however, that the steel structural part has been generally conceded to be the one outstanding branch that has maintained quality and stability. The engineers and the contractors in this line are able men and not of the type that have brought criticism upon the building industry in general. There are some fifteen or twenty steel concerns in this locality who do only high grade work and the criticism of them seems to me to be entirely unfair. I do not believe that any of those who referred to the poor quality building included the steelwork nor did they have it in mind.

Knowing the building business as I do, having spent my entire life in it, here in New York, I want to express my disapproval of any such statement which would give the impression that the structural steel is being erected in any buildings of consequence in this city by incompetent companies. I agree with much of your article but ask that you give space to this refutation.

STRUCTURAL STEEL BOARD OF TRADE, INC.,
New York City, CHAS. L. EIDLITZ, Chairman of
Jan. 4, 1926. Board of Directors.

Substitution of Ts for Ys as Junctions on Pipe Sewers

Sir—Alexander Potter's suggestion in your issue of Dec. 24, 1925, p. 1043, that T junctions should be substituted for Ys in pipe sewers is one that deserves the most serious consideration of all interested in sound sewer construction and the preservation and maintenance of roads and pavements.

In the reconstruction of many miles of sanitary sewers I found a very frequent cause of pipe failure to arise from leakage of the bend, or first pipe, following the Y junction. The escaping water often undermined the main sewer and did serious damage. Records of sewer maintenance forces under my control showed that many branch sewer stoppages were caused at the Y junction, and that stoppages elsewhere could often have been removed without breaking pavements, but that the cleaning rods could not pass the bend at the Y. Inspectors of branch sewer connections freely admit that they often have to pass sewer connections without seeing the actual connection to the main sewer, because the contractor for the connection cannot hold the loose earth in the main ditch, and to wait for an inspection would do great damage to pavements.

Where sewers are not at exceptional depth the soundest construction in sewers over 10 in. in diameter is a T junction with the branch connection from the T at right angles to the main sewer and at a true grade until the pavement line is crossed, or better still to the street line. Such a connection will seldom stop up, and if it does can easily be cleared either by rods or hose.

Engineers who buy sewer pipe will find that the breakage in T junctions, especially in larger sizes, is materially less than in Y junctions. Manufacturers can produce T junctions at less cost and with less breakage in every stage than Y junctions, and if the use of T junctions became more universal the reduction in manufacturing cost should lead to a reduction in price. It would be interesting to hear the views of either engineers or manufacturers upholding the use of Y junctions in sewers of 12 in. or larger diameter. My practice for years has been in accordance with Mr. Potter's suggestion.

A. G. DALZELL,
Toronto, Ont., Consulting Engineer.
Dec. 29, 1925.

Embrittlement of Duralumin a Serious Problem

Sir—Your editorial of Nov. 26, 1925, on "Duralumin and the Shenandoah," and the subsequent editorial of Dec. 17 constitute a most timely and valuable contribution to the problem of selection of materials for aircraft construction.

The problem of embrittlement of duralumin is one of the most serious that an engineer tempted to use that material must consider. The discovery of this phenomenon is fairly recent, and the extent to which the material is affected is as yet unknown. At first it was believed to occur only when the duralumin was subjected to specially unfavorable conditions, such as contact with a solution of calcium chloride. More recently it has been found in material subjected only to normal aging, but only in sheets of very thin gage. The Air Service, Bureau of Aeronautics, and the National Advisory Committee for Aeronautics are studying the subject.

Your suggestion that it may be due to lack of heat treatment is controverted by data already obtained, as it has been found in heat-treated material. In fact all duralumin used in structural members is heat-treated, as otherwise it would have only the properties of soft aluminum and its ratio of strength to weight would be too low for economical use in aircraft. If you had said *proper* heat treatment you might have hit upon the cause of the phenomenon; the character of heat treatment is being studied.

Duralumin has been extensively advertised, particularly in the daily press, as a kind of panacea for the tribulations of the airplane designer. As a matter of fact it increases his trials and is one of the chief causes of his gray hairs. The Army Air Service has experimented with it extensively and is continuing its investigations as energetically as funds permit. It realizes, however, the many problems connected with its use, and that of embrittlement is one of the chief reasons why it does not have greater use as a substitute for wood in Army airplane design.

Uninformed persons are liable to measure the merit of an airplane wing by the proportion of metal, particularly duralumin, entering into its construction. Those who are cognizant of the facts, however, know that at the present time well designed wings of wood construction are lighter and more reliable than any "all-metal" types that have been tested in service in this country. Until recently it was believed that it would soon be desirable to substitute duralumin for wood in wing construction, as steel has been substituted for wood in body or "fuselage" construction. It appears now that wood will retain its present place as the best material for wings for some time, as the density of steel and the embrittlement of thin duralumin make it very difficult to design satisfactory wings of either material.

McCook Field, ALFRED S. NILES, JR.,
Dayton, Ohio, Chief, Structures Branch, Engineering
Dec. 29, 1925. Division, U. S. Army Air Service.

Parabolic Sections for Banked Curves

Sir—With reference to the letter of E. G. Walker in regard to banked curves which appeared in *Engineering News-Record*, Dec. 31, p. 1084, I would say that no engineer should design a banked section on a curve of such shape that once a car starts to skid from too much speed there will be an increased tendency to skid.

If you use a straight banked section the tendency to skid remains the same. If you use a concave parabolic section the tendency to skid will decrease. If you use a convex parabolic section the tendency to skid will increase.

No engineer should design a banked section on a curve of such shape that once a slow moving vehicle starts to slide toward the center of the curve there will be an increased tendency to slide.

If you used a straight banked section your tendency to slide remains the same. If you use a concave parabolic section the tendency to slide decreases. If you use a convex parabolic section your tendency to slide increases.

These facts are as true for the outside lane on a curve as they are for the inside lane. It therefore follows that for safety on a two-lane road the best section is the concave, next is the straight, and last is the convex.

I believe that Mr. Walker is talking about a four-lane road. The design suggested was for a two lane road and we do not widen our curves enough to get more than two safe lanes.

C. J. MYERS,
Utica, N. Y., Senior Assistant Engineer, New York
Jan. 2, 1926. Department of Public Works.

News of the Week

CURRENT EVENTS IN THE CIVIL ENGINEERING AND CONTRACTING FIELDS

New Swing-Johnson Bill for Colorado River

Reservoir in Black or Boulder Canyon —Operation to be Subject to the Colorado River Compact

Important changes in the plan of the original Swing-Johnson bill for construction of the Boulder Canyon dam on the Colorado River and the All-American Canal to the Imperial Valley are embodied in the terms of a new Swing-Johnson bill that has just been introduced in Congress. It provides for construction by the government of a storage reservoir in Black or Boulder Canyon for 20,000,000 acre-ft. storage, construction of a canal from Laguna Dam or other suitable diversion point into the Imperial Valley, and construction of such other canals and structures as may be necessary to deliver water from the reservoir to irrigable lands in Arizona, Nevada and California which may be found practicable of reclamation. All construction and utilization under the terms of the bill are to be subject to the terms of the Colorado River compact, and the bill contains specific ratification of that compact, contingent upon approval of the compact by the Legislatures of six (instead of the original seven) of the states of the Colorado River basin.

The sum of $70,000,000 is authorized to be appropriated for the purposes of the act, this sum to be repaid from power leases; it is specifically provided that no part of the construction cost (except of canals) is to be charged against the lands irrigated from the reservoir. In applications for the lease of power privileges, preference is to be given to states, cities, irrigation districts, or other governmental units, and such governmental units may, instead of leasing, acquire their share of power rights in perpetuity by purchase in 25 installments, the first five of which are to cover half the purchase right. Settlement on public lands included in any of the areas to be irrigated from the reservoir or the river under the works constructed according to the bill is to be carried out with a three-months preference to ex-soldiers.

Comment on the Bill

Commenting on the bill from the power standpoint, O. C. Merrill, secretary of the Federal Power Commission at the request of Senator McNary, has submitted a number of proposals for changes in the bill. He suggests that power development should be handled in a single development and by a single lessee, that the government should finance and construct the power plant but the lessee should operate it, that the property become vested in the lessee at the expiration of the period of payment, that the government finance the entire undertaking by issue of bonds rather than by appropriation from the Treasury, and that the entire administration of the project after construction be placed under the provisions of the Water Power Act and under the administration of the Federal Power Commission.

With regard to the provision of the bill referring to several simultaneous leases of power, he says that lessees should be required to pool their interests to provide for the construction of a single power plant and operation by a single operator. The entire undertaking should not be begun until definite power agreements have been signed. Financing of the power plant construction by the government would reduce complications and simplify the business problems of the power development. Safeguards of various kinds prescribed by the Federal Water Power Act should be applied to this development, among them various provisions regarding maintenance, rates, accounting, and transfer of the property.

As all other power projects under federal jurisdiction are administered by the Federal Power Commission, Mr. Merrill holds that the leasing of power privileges at the Boulder Canyon dam also should be in the hands of the commission. He holds that the application

(Concluded on p. 37)

Engineering Fifty Years Ago

From *Engineering News*, January, 1876

Common Roads

CHOICE of a route will often make a great difference in the quality of the road obtained. Does it not strike one that the location on a section line, for the sake of not dividing land unequally, is unlikely to be the best route? The services of an engineer to lay out a road on a predetermined line is sometimes obtained, although this amount of professional assistance would be looked upon by many towns as a too expensive luxury; but it is rarely that he is called upon to locate where his judgment would dictate, to fix the most advantageous grades, and to suggest the manner of construction. There is room for much improvement in this respect, and any small addition to the first cost thus incurred would soon be returned by diminished cost of maintenance. Facts and figures can be given from examples in this country as well as abroad, and we may have more to say on this subject at another time.

Legislative Road Locations Subject to Change

Missouri Court Finds That Highway Commission May Change the Legislative Designations

The Missouri Supreme Court, on Dec. 30, upheld the authority of the Missouri State Highway Commission to change the legislative designation of the primary or higher type roads in the state highway system in the interest of economy or directness of routes. The decision was in the test case originating in St. Charles and Warren counties over a relocation of state highway No. 2 and settles the legal points raised in the Fulton road injunction suit now pending before the Cole County Circuit Court.

In the Fulton case some residents of Callaway County sought to prevent the state commission from making a similar relocation of route No. 2 through Callaway and Boone counties. This suit has tied up the paving of 22 miles of road. The Cole County Circuit Court issued a temporary injunction against the commission on Aug. 20, last. The Callaway county complainants had alleged that the commission had no legal right to relocate route 2 or change it from the route designated by the state legislature in laying out the state highway system.

The Supreme Court, in the decision written by Judge Atwood, holds that under the road law the commission has full power to make such changes as it might deem necessary in the routing of the 1,500 miles of primary roads when such changes are in the interest of either economy or directness of route. Judges Blair, Ragland and White concurred. Judge Atwood held that the provisions show that it was the intent of the legislature that the commission should have this discretion and "we hold such discretion is well vested."

Judge W. W. Graves dissented and in a separate opinion held the commission without authority to relocate primary roads.

Many Injured in Collapse of Stand at Pasadena

The collapse of a temporary grandstand at the corner of Madison St. and Colorado Ave. in Pasadena, Calif. on Jan. 1, during the Tournament of Roses parade, resulted in serious injury to many people, two of whom since have died, according to press report. A third person, a woman who witnessed the collapse, died from shock.

No details of the construction of the stand are available at present.

The coronor's jury is reported to have placed the responsibility for the accident upon Paul F. Mahoney, the builder, and upon the Building Department of Pasadena.

WASHINGTON NOTES

INDICATIONS all are that General Edgar Jadwin will be chosen Chief of Engineers when General Harry Taylor retires in June. The names of Col. Charles L. Potter, the president of the Mississippi River Commission, and Col. Herbert Deakyne also are being mentioned prominently in connection with the succession. Col. Charles W. Kutz is expected to be the choice for assistant chief, which carries with it the rank of brigadier general.

APPLICATIONS for licenses on the Osage River and on the Kentucky River will be considered at a meeting of the Federal Power Commission to be held before Jan. 15. The Tennessee River applications, which were considered at the recent public hearing in Chattanooga will not be ready for presentation to the commission at this meeting. These applications probably will be ready to present to the commission for action by the middle of February.

TENNESSEE politics is responsible for much of the clamor which has arisen over the water power applications on the Tennessee River. Senator McKellar has found frequent occasion to attack privately-owned utility companies and to advocate public ownership. Governor Austin Peay is an opponent of public ownership and apparently has scored heavily against Mr. McKellar at the recent hearing before the district engineer at Chattanooga.

That the development of the Tennessee River by the state would not meet favor among the voters at this time is indicated by the recent overwhelming defeat of a bond issue for roads. Approval for any issue of securities committing the state to the large expenditures which would be necessary were it to embark in the power business, is out of the question, in the belief of many who are familiar with the situation.

CALIFORNIA'S efforts to bring about an agreement as to the disposition among the lower states of the Colorado River basin of the 7,500,000 acre-ft. of water which passes Lee's Ferry have revealed wide differences of opinion as to the allocation. California, which contributes no water to the river and which has only a few square miles in the drainage basin, wants recognition of 2,146,000 acre-ft. of perfected rights and to a diversion of 1,095,000 acre-ft. for use by Los Angeles.

California would allocate 300,000 acre-ft. to Nevada and 500,000 acre-ft. to Mexico. When all these amounts are added together a total of 4,273,000 acre-ft. is obtained. This would leave 3,227,000 acre-ft. of the total passing Lee's Ferry. This amount California would divide equally between herself and Arizona. This added to the amount mentioned would give Arizona 1,845,500 acre-ft. and California 4,854,500 acre-ft.

The Arizona committee figures differently. Under its plan California would receive but 3,350,000 acre-ft. Arizona agrees to the 300,000 acre-ft. for Nevada and the 500,000 acre-ft. for Mexico which, when deducted from the 7,500,000, leaves 6,700,000 acre ft. This, the committee proposes to divide equally between the two states, or 3,350,000 acre-ft. each. In addition, Arizona reserves for herself the waters of her own rivers which add 2,563,000 acre-ft. to the Colorado River total. A considerable part of this latter total can not be utilized, due to the wide variation in the discharge of the Arizona rivers.

Engineering News-Record is a consolidation of *Engineering News* and *Engineering Record*, effected in 1917.

Engineering News was founded in 1874 by George H. Frost, as the *Engineer and Surveyor*, which title subsequently became the *Engineer, Architect and Surveyor*, then *Engineering News and American Railway Journal* and finally *Engineering News*, under the successive editorships of D. McN. Stauffer, Arthur M. Wellington and Charles Whiting Baker.

Engineering Record was established in 1877 by Henry C. Meyer as the *Plumber and Sanitary Engineer*. The name was subsequently changed to the *Sanitary Engineer, Engineering and Building Record* and, finally to *Engineering Record*. During his ownership of the paper, Mr. Meyer was directly responsible for the editorial policy. John M. Goodell became editor in 1902, and was succeeded by E. J. Mehren.

The Contractor was consolidated with *Engineering News-Record* in 1918.

E. J. Mehren became editor of *Engineering News-Record* at the time of the consolidation in 1917, and was succeeded by Frank C. Wight, Jan. 1, 1924.

The staff of *Engineering News-Record* consists of

New York: Frank C. Wight, *Editor;* M. N. Baker, F. E. Schmitt, C. S. Hill, J. W. Shaver, V. T. Boughton and W. G. Bowman.

Chicago: W. W. DeBerard, E. E. R. Tratman.

San Francisco: N. A. Bowers.

New Bridge Opened at Portland

The Sellwood bridge across the Willamette River at the southern edge of the city of Portland, Ore., and the first of the new bridges included in the city's bridge program, was opened to traffic on Dec. 15. Two others are under construction.

Snow Removal to Be Discussed at Chicago Convention

A half day's session of the American Road Builders' Association at Chicago, Jan. 11 to 15, inclusive, will be devoted to the discussion of methods of snow removal from highways during the winter months.

Cornell Engineers Dinner to Be Held January 22

Through an inadvertence, circulars of the American Society of Civil Engineers announcing the annual meeting in New York City omitted in the page of college dinners a reference to the dinner of the Cornell Society of Engineers. This will be held at the Hotel Pennsylvania, New York City, 7 p.m., Jan. 22. Tickets may be obtained from John W. Ripley, treasurer, 50 Church St., New York.

$73,125,000 Apportionment for Federal-Aid Roads

Secretary of Agriculture Jardine has announced the apportionment of $73,125,000 to the states for use in the construction of federal-aid roads. This apportionment was authorized by the Post Office Appropriation Act of February 12, 1925 and is for the fiscal year beginning July 1, 1926.

The new funds will be spent entirely on the federal aid highway system under the same plan of co-operation with the states that has been in successful operation for ten year. The bureau reports that approximately 10,000 miles of federal-aid road were brought to completion during 1925.

Attacks War Dept. Procedure on San Francisco Bay Bridge

In a written statement not read in full at the recent hearing on San Francisco Bay bridges reported in *Engineering News-Record*, Dec. 31, 1925, p. 1086, L. M. Cox, consulting engineer, San Francisco, urged that the policy which the federal government has followed with regard to San Francisco Bay bridges be changed. He said that the course of action pursued by the War Department has constituted "a positive discouragement to the financing and construction of a needed public utility and its effect has been to suspend all serious effort to study the question for three years," and demanded that the department confine itself to a definition of principle, or design criteria, to which a project must conform before receiving favorable consideration. After reviewing conditions affecting various phases of the problem, Mr. Cox recommended that the department policy be so amended as to impose definite criteria for crossing obligations instead of type and site limitations, and offered the following as illustrating a proper form of stating these criteria:

"That no trans-bay crossing will be favorably considered which will result in: (a) A substantial increase in tidal currents; (b) appreciable alteration in tidal flow calculated to induce dangerous silt deposits or otherwise injure the Bay regime; (c) serious menace or source of inconvenience to navigation; (d) invitation to enemy attack; (e) hazard to naval channels through demolition. These criteria might well be elaborated by specific limitations as to width of spans, depth of tunnel covers, overhead clearances, etc."

More Towns Approve Bridge Over Detroit River

Two more border municipalities in Canada have voted in favor of the proposed international bridge spanning the Detroit River between Detroit, Mich., and Windsor, Ont. With the approval by Sandwich and Walkerville, Ont., six of the border cities now have endorsed the proposal and there remain only two more, Riverside and LaSalle to ballot on the proposition early in January.

In Walkerville the vote stood 1084 for and 708 against the proposition, while in Sandwich where the Canadian end of the proposed bridge would be located the majority was over 15 to 1 in favor of it. The elections held are plebiscites giving only expressions of opinion and are not binding in any way on any of the towns. A strong sentiment in favor of the plan presented by Joseph A. Bower has been shown by the balloting. This plan calls for financing a $16,000,000 structure and a debenture issue of $6,000,000 backed by the Canadian government.

Applications for Power Sites on Holston River to Be Heard

There is to be a public hearing at Bristol, Va., on Jan. 11, in connection with the pending applications for preliminary permits to construct power dams on the Holston River and its tributaries in Tennessee. At present there is only one applicant, the Holston River Power Co., which proposes a total installation of 74,000 hp., 24,000 hp., and 30,000 hp. at two sites on the Holston River, and 20,000 on a tributary, the South Fork.

New Swing-Johnson Bill for Colorado River

(*Concluded from p. 35*)

of the provisions of the Colorado River compact to all developments on the river for any purpose appears to be an essential element in a comprehensive scheme of river development. That part of the dam which is reserved for flood control should, in his opinion, not be charged to the power developed, but should be charged to the land protected, for which he calculates a total charge of $9.70 per acre now protected and $4.40 per acre ultimately protected (this area taken as 1,370,000 acres).

In a separate memorandum of amendatory suggestions, Mr. Merrill recommends that "the project be turned over to the licensee for operation upon completion." Whereas the bill provides that title to the plant is to remain vested in the government, he proposes that "the properties constructed or acquired from the proceeds of the project fund become the property of the licensee, subject, however, if the irrigation districts have fulfilled their obligation, to the requirement forever to maintain available for flood control the prescribed storage capacity or so much thereof as may be necessary."

Engineering Schools to Unite

A movement now on foot to unite the engineering school of Northwestern University, Evanston, Ill., and the Armour Institute of Technology, Chicago, is favored strongly by the authorities of both institutions and it is expected that definite arrangements will be concluded early in 1926.

Bursting of 16-In. City Water Main at Oakland, Calif.

A length of 16-in. cast-iron water main in Oakland, Calif., burst on Dec. 19 causing extensive property damage before the flow could be stopped. The pipe was ⅜ in. thick and had been in service without giving trouble for seventeen or eighteen years. The break was not a single rupture but was a complete shattering of the entire pipe length. The usual pressure of 70 lb. per sq.in. was on the line at the time. Prior to the break there had been no change in pump pressure or any valve closure that might have caused water hammer. The rupture occurred at 24th Ave. and East 12th St. where a 16-in. cast-iron line is taken off a 36-in. main only a few feet from a pumping station. The top of the 16 in. main was about 3 ft. below a 6-in. asphalt-surfaced, concrete pavement and a few feet away from but not under the Western Pacific R.R. tracks.

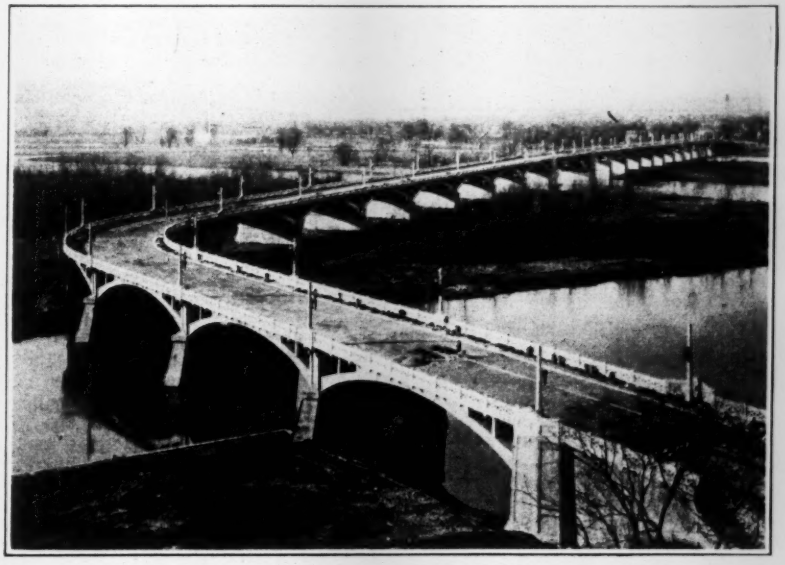
Name Judges for Good Roads Essay Contest

The American Road Builders Association has announced the appointment of the following men as judges in the association's "Good Roads Essay Contest," now being conducted in various colleges and universities: Thomas H. MacDonald, chief, United States Bureau of Public Roads, Washington, D. C.; William H. Connell, president, American Road Builders Assn., Harrisburg, Pa.; C. R. Ege, president, Highway Industries and Exhibitors Assn., Chicago, Ill.; S. S. Steinberg, assistant director, Highway Research Board, National Research Council, Washington, D. C., and Arthur H. Blanchard, professor of highway engineering, Michigan University, Ann Arbor, Mich.

Prizes totaling $550 are being offered for the best essays not exceeding 600 words on the subject "A New Country by Improved Highways." The contest is open to all college students. Announcement of the winners will not only be made to the convention but will be made by radio during the week.

Buffalo Adopts Zoning Ordinance

A new zoning ordinance for Buffalo, N. Y., has been unanimously adopted by the city council. The ordinance divides the city into residential, business and factory districts, and provides for a board of appeal. When it goes into effect, applications for permits for buildings, garages, gasoline stations, factories, etc., heretofore passed upon by the city council, will go to the building commissioner for action.



Schenectady-Scotia Bridge Opened for Traffic

The highway bridge over the Mohawk River between Schenectady and Scotia, N. Y., known locally as the Great Western Gateway, was completed and opened to traffic in December. The picture shows the bridge as the last contract was being completed, that of the Hastings Pavement Co., for the asphalt block paving.

Shortage of Draftsmen

The United States Civil Service Commission states that there is immediate need for additional design, detail and copyist draftsmen for hull work at the New York Navy Yard. The commandant of the yard can make use of a reasonable number of mechanical draftsmen, structural-steel draftsmen, ship-piping draftsmen, or ship-ventilating draftsmen. Full information and application blanks may be obtained from the secretary of the Second United States Civil Service District, Custom House, New York City.

Engineering Societies

Calendar

Annual Meetings

AMERICAN ROAD BUILDERS ASSOCIATION, New York City; Annual Convention, Chicago, Ill., Jan. 11-15, 1926.

AMERICAN ENGINEERING COUNCIL, Washington, D. C.; Annual Meeting, Washington, D. C., Jan. 14-15, 1926.

ASSOCIATED GENERAL CONTRACTORS OF AMERICA, Washington, D. C.; Annual Meeting, Portland, Ore., Jan. 19-23, 1926.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York City; Annual Meeting, New York City, Jan. 20-22, 1926.

ENGINEERING INSTITUTE OF CANADA, Montreal; Annual Meeting, Toronto, Ont., Jan. 27-29, 1926.

AMERICAN CONCRETE INSTITUTE, Detroit, Mich.; Annual Meeting, Chicago, Ill., Feb. 23-26, 1926.

The Mississippi Valley Conference of State Highway Departments will be held in Chicago, Ill., Jan. 14-16, during the week of the Road Show. The greater part of Thursday will be given over to group conferences and all day Friday and Saturday morning to addresses. The meetings are open only to members of the association and those county highway engineers whom the executive officers of the State Highway Department may invite.

The New England Water Works Association will hold its regular meeting on Jan. 12, with a luncheon and with two papers: Improvement of the Keene, N. H., Water-Works, illustrated, by Robert Spurr Weston and George A. Sampson, consulting engineers, Boston; and Economy of Municipal Bonds for Water-Works Construction, by Charles W. Sherman, of Metcalf & Eddy, Boston.

The National Crushed Stone Association will hold its annual meeting at Montreal, Quebec, Jan. 18-21, 1926. J. R. Boyd, Earle Building, Washington, D. C., is secretary.

Personal Notes

REAR ADMIRAL LUTHER E. GREGORY, Civil Engineer Corps, U. S. N., has been reappointed chief of the Bureau of Yards and Docks for four years beginning Jan. 6, 1926, having served a similar four-year term since 1922. Mr. Gregory had previously performed duty as public works officer in the navy yards and naval districts at Puget Sound, Wash.; Boston, Mass.; the first naval district; Charleston, S. C.; Portsmouth, N. H.; and the Norfolk navy yard.

GLOSTER P. HEVENOR, HAROLD F. SMEED, LEWIS B. SMITH and W. EARL WELLER of Rochester, N. Y., announce the formation of an organization known as Hevenor & Weller, Inc., with offices in the Burke Building, Rochester, for the practice of civil engineering.

CHARLES DERLETH, JR., dean of the College of Civil Engineering, University of California, has resigned the chairmanship of the Arch Dam Investigation Committee of Engineering Foundation but will continue as a member of the committee. CHARLES D. MARX, professor emeritus of civil engineering, Leland Stanford, Jr. University, has been appointed chairman of the committee.

CARL L. VAN VOORHIS, Mt. Vernon, Ohio, has been named chief engineer for the Ohio Crushed Stone Association, which has general offices in the Hartman Building, Columbus. He is secretary of the Ohio Engineering Society and was field engineer for the Ohio Good Roads Federation for two years. He was also surveyor of Knox County, Ohio, for several terms.

THOMAS O'BRIEN, for the past fifteen years engineer and sales manager for The John F. Allen Co., New York City, has resigned to go into business for himself.

L. C. SABIN, general superintendent of the St. Marys Falls Canal, Sault Ste. Marie, Mich., has been elected vice-president of the Lake Carriers Association with headquarters in Cleveland. Mr. Sabin succeeds J. S. Ashley, who was elected president following the death last October of William Livingstone, president of the association since 1902. Since 1906 Mr. Sabin has been general superintendent at the Soo, where he has taken a leading part in widening and deepening the canals, constructing the new emergency dam and the compensating works for Lake Superior and the new navigation canal with the third and fourth locks. Graduated from the University of Michigan in 1890, he immediately started work at the Soo as assistant engineer on the construction of the Poe Lock, and, with the exception of three years hydraulic investigation of the Great Lakes at Detroit and two years as secretary of the American Section of the International Waterways Commission at Buffalo, has been continuously at the Soo.

MAJOR THOMAS F. FARRELL, Corps of Engineers, U. S. A., has been appointed commissioner of canals and waterways of the New York State Department of Public Works, to succeed ROYAL K. FULLER, who has resigned. Major Farrell is a civil engineering graduate of Rensselaer Polytechnic Institute. From 1913 to 1917 he was an engineer on work on the Panama Canal; then he saw service in France with the 1st Engineers. Since the War he has been engaged on river and harbor work at Norfolk, Va., and has been instructor in engineering at Fort Humphrey and at West Point, the latter being his present post.

A. L. DUNBAR, Buffalo, N. Y., engineer and formerly chief of plant construction for the National Aniline and Chemical Co., is now connected with R. R. Kitchen & Co., general contractors, Wheeling, W. Va., in the capacity of assistant to R. R. Kitchen in charge of field operation.

JAMES C. ADAMS, Binghamton, N. Y., at present connected with the city engineer's office, has been appointed superintendent of sewers in Binghamton. Mr. Adams entered the Binghamton city engineering office in 1912, after five years' service in Barge Canal work in the office of the New York state engineer, and by 1920 had been promoted to the position of deputy city engineer of Binghamton. Then for three years he was construction engineer for the A. W. Bowie Construction Co. and in 1923 returned to city work on sewers in Binghamton.

Obituary

THOMAS H. GATLIN, Washington, D. C., of the firm of Gatlin & Wolfe, consulting engineers, died Dec. 25 in a hospital after a short illness, his age being 48 years. Mr. Gatlin was formerly for twenty years chief engineer of construction of the Southern Railway system, until 1924, and at the time of his death was vice-president and chief engineer of the firm of B. F. Johnson, contractors, Baltimore. He was born in Tarboro, N. C., and graduated from Trinity College, now Duke University, at Durham, N. C.

COL. WILLIAM F. M. MCCARTY, an engineer and chemist, who served with distinction in the Confederate Army, died Jan. 3 at his home in Baltimore, Md.; he was 85 years of age. Following the Civil War Colonel McCarty continued the study of engineering and chemistry and spent some time in Mexico. Later he went to Paris and then to Russia. In the latter country he served as a colonel of engineers in the Russian Army and took an important part in the development of railroads and mines. Returning to the United States early in the '80s he spent a number of years in western Maryland. During the world war he was director-general of the Canada Nitro Products Co. He continued active in his profession until about fifteen months before his death.

From the Manufacturer's Point of View

A Point of Contact Between Maker and User of Construction Equipment and Materials

Recent Developments in Equipment For the Road-Builder

THIS issue of Engineering News-Record immediately preceding the Good Roads Show in Chicago, Jan. 11-15, has been planned especially for highway engineers and contractors. The following descriptions are devoted exclusively to equipment used in highway construction and maintenance work. Additional descriptions of road building machinery will be published next week and a detailed story of the Road Show will appear Jan. 21 in the Convention Report number.—EDITOR.

Simplified Boom Mechanism on New Power Shovel

A 1¼ yd. gasoline shovel, which may also be converted for crane or dragline service is a most recent addition to the machines manufactured by the Thew Shovel Co., Lorain, Ohio. As far as outward appearances are concerned, the machine departs from past practice most noticeably in its boom design. All mechanism on the boom has been eliminated except a shipper shaft with sprocket and pinion. The shipper shaft

passes through the center of the boom and is claimed to permit a greater working range for a given length of boom and stick. The machine is known as the Lorain 75. The clearance dimensions are the same as for ¾ yd. machines and the working ranges equal or exceed those of 1 yd. shovels.

The machine is controlled by 3 levers and large power operated friction clutches. Jaw clutches are not used except for travel and derricking speed changes. Power is applied to the shafts directly and independently by a simple pinion gear driven from the engine by a silent chain. Power plant is either a Waukesha or Buda 75-hp. gasoline engine. The machine is enclosed in a steel cab standing 11½ ft. from the ground and the whole is mounted upon a center drive truck. Crane and dragline booms are furnished in lengths up to 50 ft.

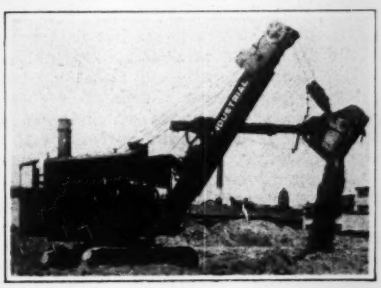
Steel Road Form of Simple Design and Sturdy Construction

Among the many advantages of the new steel road form manufactured by the Truscon Steel Co., Youngstown, Ohio, is its simplicity of design, which is said to permit a big saving of time in placing. It is built throughout of new billet open hearth steel $\frac{3}{16}$ in. thick. The top flange of the form is 2 in. wide with 1½ in. return, providing a rail for the finishing machines. Wide bearing is secured with a 6 in. bottom flange. The stakes are made of special grade hard steel, ¾ in. in diameter, 18 in. long and properly pointed. They are spaced 1½ in. from the ends and 5 ft. on centers. Three-point contact holds them rigidly in position.

Another feature is their sliding end connections and ½-in. bearing, which is claimed to assure alignment without danger of displacment. All forms are punched with holes 3 ft. on centers for bolting on strips to provide wider forms where necessary and with extra stake holes on the outer edge for additional anchorage. They are furnished in standard heights of 6, 7, 8, and 9 in. and in one standard length of 10 ft.

Improvements on Combination Shovel, Crane and Dragline

The type DC machine manufactured by Industrial Works, Bay City, Mich., which may be operated as a 12½-ton crawling tractor crane, a ¾ yd. power shovel and a 1-yd. dragline has been improved in several particulars. A patented steering arrangement is said to give positive control with friction



clutches. The large rollers in the crawler treads are of the self-cleaning type. Special slewing engines are used and a special steam crowding engine placed on the steam shovel. The machine is built for steam, electric, gasoline or Diesel engine power. Another improvement is made in providing two speeds for propelling and hoisting.

The machine is full revolving and all castings are made of steel. The system of operating drums on the machine gives automatic control of the bucket opening line and in addition allows the bucket to be hoisted in open position on the opening line. Booms up to 50 ft. in length are available for crane and dragline duty.

Bituminous Fillers Applied by New Squeegee Machine

The new squeegee machine, manufactured by Littleford Bros., Cincinnati, Ohio, can be used equally well for applying bituminous fillers on all kinds of brick or block pavings and wood block floors, or for applying asphaltic seal coats. It is claimed to be very economical in operation and to make a much neater job than the old method of hand squeegeeing where much material was wasted by uneven spreading.

The machine consists of a hopper which is mounted on two wheels. The hopper capacity is 12 gal. A quick-acting valve with a convenient control

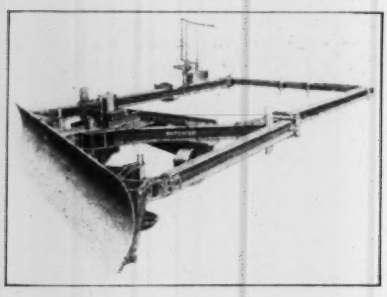
rod discharges the hot material directly in front of the curved wiper blade in quantities as needed. This blade has a spread of 25 in. It is made of heavy rubber and is reversible and adjustable for wear. The machine is light enough to be handled by one man and when in operation is held so that the entire weight of the outfit is supported on the wiper blade. The small wheels are required only when turning the machine around or when it is moved on and off the job.

Snow Plow Attachment Operated by Hydraulic Jack

A straight blade snow plow for 5 and 10 ton tractors is a new snow moving tool recently developed by the Baker Mfg. Co., Springfield, Ill. This plow is an independent unit which can be attached to any 5 or 10 ton tractor without permanent connections to the tractor and as easily as attaching a good road grader. The tractor is run in between the sidebeams of the plow, guide chains connected at the front of the

tractor and two pins inserted through the tractor draw-bar. It is then ready for service. It can be connected or detached in ten minutes.

There is no weight on the tractor as

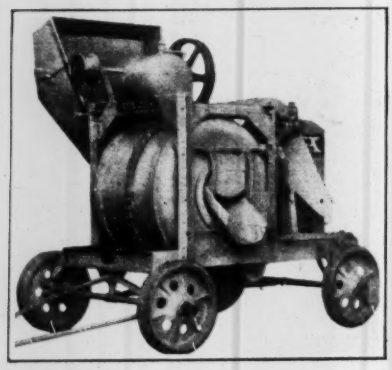


the plow is lifted from the frame which is supported by carrying wheels equipped with Hyatt roller bearings. Lifting is accomplished by means of a hydraulic jack operated by a hand pump located on the plow frame near the driver's seat. It is claimed that the plow can be lifted in less than half a minute and lowered almost instantly by means of a release valve. Patent tripping blades are used on this plow, providing protection in case obstacles are encountered on the roadway.

New 5-S Concrete Mixer Has Improved Loading Action

A new concrete mixer designed as a full bag mixer on a 1:2:4 mix has just been announced by the Chain Belt Co., Milwaukee, Wis. The machine, a 5-S, has many new features and improvements which were developed through field tests. It has a capacity of 5 cu.ft. of mixed concrete, a wheel base of 64 in. and weighs 2,950 lb. when equipped with a power loading skip. This light weight is claimed to have been made possible through extensive use of certified malleable castings.

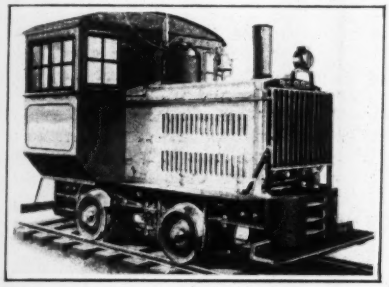
Among the features of the machine is a knockout device which automatically throws out the clutch when the charging skip has reached its height. Grooved winding drums and a pivot shaft have been designed for smoother and quicker loading action. Power consists of a 4-hp. gasoline engine. This engine is hopper cooled and has a device which automatically fills the tank with water. The new machine is equipped with steel roller chain drives which provide smooth operation and long life for the mixer.



New 12-Ton Gas Locomotive for General Construction Work

The most recent addition to the line of Plymouth locomotives manufactured by the Fate-Root-Heath Co., Plymouth, Ohio, is known as its Model JLB, weighing 12 tons. The power unit on the locomotive is a Buda 6-cylinder engine, developing 88 hp. at 1,400 r.p.m. The transmission is of the sliding gear type using four speeds forward and reverse. These speeds are 3½, 5½, 11 and 18 m.p.h. at an engine speed of 1,400 r.p.m. All gears are of alloy steel cut and hardened. The 5¼-in. axles of alloy steel ride on heavy-duty Hyatt bearings lubricated by the Alemite system. Hand-operated brakes engage all four wheels. If desired, the locomotive may be equipped with a Westinghouse direct air system.

The machine is built in all gages from 23⅝ to 56½ in. with a wheel base of 63 in. Length overall is 15 ft. 8 in. and height, 9 ft. 10 in. The usual accessories of electric lights, whistle, bell and cast-steel bumpers are provided.

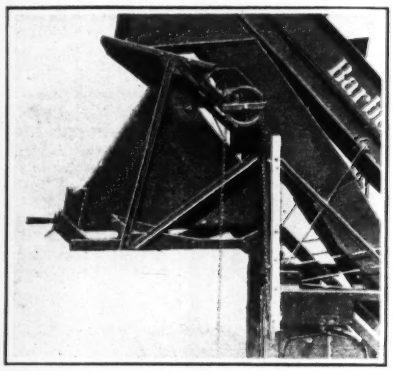


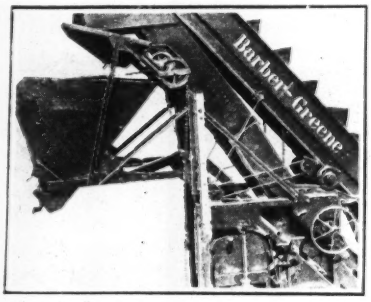
The cab is made especially wide so as to enable the operator to see out alongside railroad cars. This locomotive is adapted to quarries, gravel and clay pits, mining, railroad and general construction work.

Uniform Hopper Charges of Sand and Stone by Strike-Off Device

The strike-off hopper manufactured by Barber-Greene Co., Aurora, Ill., and used as an attachment for its self-feeding bucket loader assures uniform volumetric charges of sand and stone in concrete proportioning. When the hopper is set, as shown in the upper illustration, it is filled to overflowing. As it is tilted to reach the position shown in the lower illustration, the pan at the top, which remains fixed, strikes off the excess material at the beginning of the tilting movement. This excess material goes down the back of the hopper to a return chute which takes it to the disk feeder at the bottom of the bucket elevator. A latch holds the discharge opening closed until the strike-off action is completed.

By means of the series of holes shown on the side of the hopper, a capacity variation is possible from 8 to





23 cu.ft. by ½ cu.ft. increments. The entire hopper mechanism is hinged to the upright frame of the bucket loader and may be swung to a position 90 deg. from that shown in the illustration. This detail is used on the machine so that the top of the bucket elevator boom may be lowered when it is necessary for the machine to pass under low obstructions.

Motor Grader Designed for Heavy Road Work

The new motor grader of the Austin-Western Road Machinery Co., Chicago, which incorporates for a power plant the McCormick-Deering tractor manufactured by the International Harvester Co., has been designed to meet a demand for a machine of increased size and strength. The important points claimed for this piece of road equipment are the position in which the operator is placed, leaning front wheels, great power and massive construction, scarifier attachments, and the ease with which it is controlled.

The rear of a motor grader is said to be the correct position for the operator's platform. From here he can see the high and low spots in the road and also steer the machine while keeping his eye continuously on the road ahead. All adjustments of the blade, vertical, diagonal, and lateral, are made from the operator's platform on this motor grader.

Crawler tread or rubber tired wheels are furnished. Leaning front wheels are provided as the company claims that only in this way can the tractor be kept from sliding sideways. It is pointed out that the front end of an ordinary grader is hooked to a team or tractor which holds it in the road.

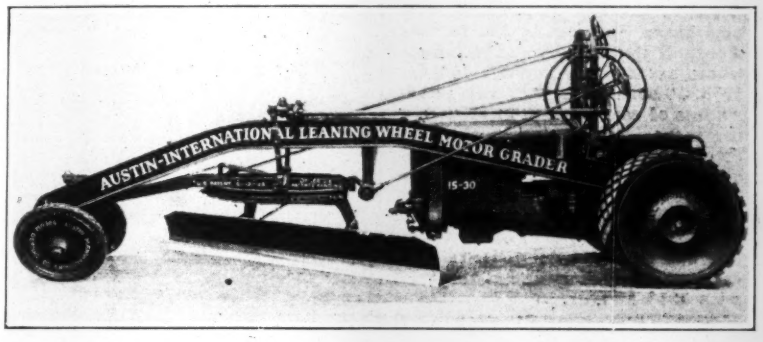
Elimination of this side-moving tendency is claimed to result in more efficient handling by the operator since he can devote all of his time to steering and operating the blade.

Two types of scarifiers are used with this equipment. The first, known as the center type, is located directly ahead of the blade and being fastened to the blade circle is controlled by the regular blade mechanism. The second scarifier, which is attached to the rear of the motor grader, is considerably heavier and stronger than the center type and should be used when any amount of rather difficult scarifying is necessary. This rear scarifier has a transverse adjustment of 11 in. so that it can be operated close to the curb.

The machine is available in two types —a 15-30 model and a 10-20 model. The first has an overall length of 22 ft. 8 in. using a 12-ft. blade 17 in. wide and weighs 13,000 lb. complete. The second has an overall length of 18½ ft. using a 10-ft. blade 15½ in. wide and weighs 9,375 lb. complete.

These motor graders are primarily road maintainers and the rubber tired models are specially designed for work of this sort. However, a crawler

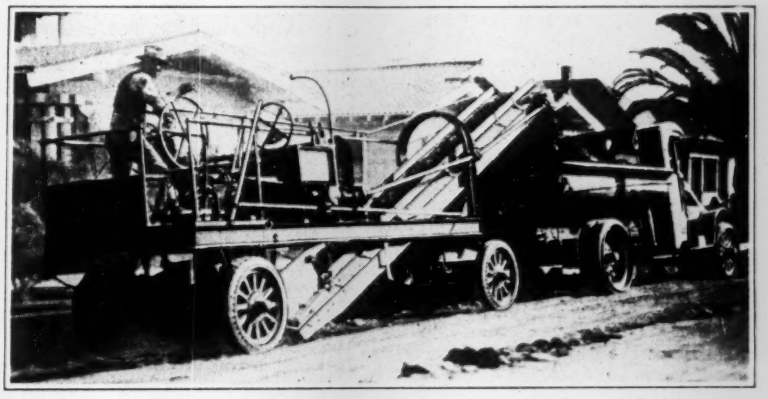
grade. The corduroys have a large bearing area and non-cloggable treads with bushed connecting pins. The smaller machine may be loaded on a standard flat car without dismantling.



mounting is available in place of the rear wheels. The power plant is of the vertical four-cylinder, valve-in-head type with replaceable cylinders.

All Main Machinery of Excavator Inclosed in Cast-Steel Case

Two ladder type trench excavators embodying several new features have recently been announced by the Harnischfeger Corporation, Milwaukee, Wis. These machines are built in two sizes, to cut trenches up to 10 ft. deep and 30 in. wide or up to 15 ft. and 36 in. wide, respectively. One important feature of these machines is that all main machinery is mounted in one cast steel case, fully inclosed. This unit contains all gears for travel, digging, feed, conveyor drive and hoist. Every motion on the machine has three speeds forward and one reverse, accomplished by a standard automobile gear shift. The control of all mechanism is centralized and may be operated from either side of the machine. The conveyor shaft and hoist is power driven. The bucket chain is driven through a friction connection, thus giving protection to the machines when digging in stony ground. A positive boom hoist and crowd are relied upon to hold the boom to exact



a picture of one of these test machines.

The excavator is composed primarily of a heavy built-up structural steel framework mounted on rubber-tired wheels with Timken roller bearings. A

End Loading Elevating Grader for Use in Narrow Streets

The new street excavator manufactured by the Western Wheeled Scraper Co., Aurora, Ill., has been designed to meet a demand for an excavating loader that can be used in narrow streets or alleys. The machine is end loading, being pulled by a motor truck into which the furrow is delivered. Commercially, this is a new machine that will be put on the market for the first time during the 1926 season. Actually, it has been in service in California during the past two years in order to test its efficiency and iron out any troubles that might develop. The illustration is

heavy plow on the left side turns the material onto a short transverse elevator underneath the framework. This elevator deposits the material into a hopper which in turn feeds it onto a longitudinal trough-shaped elevator extending forward beyond the front end of the machine. The elevators are operated by a gasoline motor and mounted on Timken roller bearings. At the upper end of the elevator there is a specially designed spout or deflector controlled by an operator on the platform of the excavator. This distributes the material evenly on the truck body, thus insuring a full and uniform load.

An especially designed automatic coupling is provided that can be released instantly by the operator of the machine by means of a lever conveniently placed. When the truck has taken on its full load, the movement of the lever releases the truck. A waiting truck then backs up to the machine and is automatically coupled to it. It is claimed that the machine will load 60 to 100 cu.yd. per hour.

Special means are provided to keep the dirt and debris from collecting on the inside surface of the belt and clogging on the rollers. Most of the falling and sifting dirt is deflected. The gasoline motor which operates the elevator solves the problem of handling material in sand or other soft material, since it makes the operation of the elevators independent of the traction of the wheels. If more power is required, a waiting truck can be utilized by pushing the machine from the rear. The machine is steered independently of the truck and therefore can swing around a manhole or other obstruction in the street or alley. It is pointed out that this machine is not designed to replace the side-loading elevating grader, but merely to do a class of work for which the latter is not adaptable.

Engineering News-Record Statistics of the Construction Industry

Jan. 7, 1926 — *in the United States* — Vol. 96, No. 1

Engineering News-Record CONSTRUCTION COST Index Number (1913 = 100)

MONTHLY

January, 1924 to Date

January, 1926	**207.15**
December, 1925	205.95
January, 1925	210.40
Peak, June, 1920	273.80
1913	100.00

1924

Jan.	217.90	May	222.38	Sept.	211.25
Feb.	220.30	June	216.85	Oct.	207.55
March	224.60	July	214.40	Nov.	205.70
April	221.60	August	213.15	Dec.	208.58

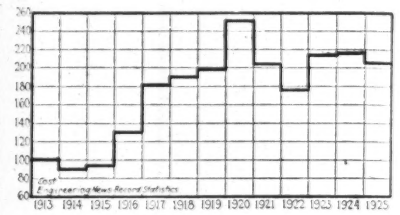
1925

Jan.	210.40	May	207.20	Sept.	202.10
Feb.	209.70	June	204.60	Oct.	205.35
March	210.20	July	204.60	Nov.	205.95
April	209.55	August	204.60	Dec.	205.95

ENGINEERING NEWS-RECORD'S Construction Cost Index Number is 1.2 points above December, 1925, owing to higher cost of lumber due indirectly to Florida demand. The average rate for common laborers is still 54c. per hr. for the entire country as against 53c. four months ago and 55¼c. one year ago. Thus general construction cost is 0.5 per cent above a month ago, 2 per cent below a year ago and 24 per cent under the peak; it is 107 per cent above the 1913 level.

YEARLY

1913 to 1925



Engineering News-Record CONSTRUCTION VOLUME Index Number (1913 = 100)

MONTHLY

January, 1924 to December, 1925

December, 1925	**206**
November, 1925	194
December, 1924	145
Peak, August, 1925	266
1913	100

1924

January	125	May	194	September	159
February	144	June	149	October	164
March	161	July	161	November	128
April	159	August	162	December	145

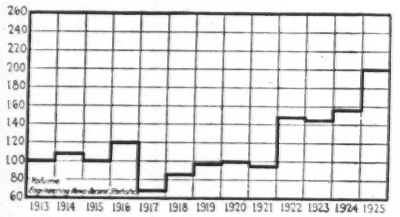
1925

January	141	May	209	September	262
February	145	June	214	October	233
March	161	July	178	November	194
April	211	August	266	December	206

ENGINEERING NEWS-RECORD'S Construction Volume Index Number is 206 for the month of December, and 201 for the whole of 1925, as against 100 for 1913. This means that the actual volume of construction in 1925 (not the mere money-value of the contracts let that year) is 101 per cent above the volume of construction for 1913. The monthly volume number, 206 for December, 1925, contains the increment of construction and indicates the rate at which contracts are being let as compared with 1913 awards.

YEARLY

1913 to 1925



1925 Record Year in Street and Road Construction

Gain in Number of Proposed Projects Indicates Good Start for Coming Season—Prices of Road Building Materials Show Little Change From Year Ago

THE heaviest road building year on record, in total money value of contracts awarded, has just closed. The total for the United States, on jobs valued at $25,000 and over, was $422,054,000 for 1925, a gain of nearly 2 per cent over the year preceding and 16.5 per cent compared with the total for 1923.

Work proposed in 1925, indicates an upward trend in the number of road projects to be started in 1926 and a slight drop in average money value per contract. In number of awards, 1925 fell below the year preceding; average value per contract, however, was higher.

The following tabulation shows the total number of projects published in the Construction News section of *Engineering News-Record* during 1925 and 1924, from the proposed stage to the awarding of the contract, also the total money value of proposed work and contracts let.

STREETS AND ROADS, UNITED STATES

	1925 Number	1925 Value	1924 Number	1924 Value
Proposed	3,294	$729,386	3,223	$852,575
Bids desired	2,182		2,230	
Bids received	965		1,003	
Contracts let	2,712	$422,054	2,776	$415,216
	9,153		9,232	

Consistent gains from year to year since 1923, have been shown in street and road contract letting in New England, the Middle Atlantic states, the Middle West, and the Far West.

CONTRACTS AWARDED FOR STREETS AND ROADS, U. S.—$25,000 AND OVER

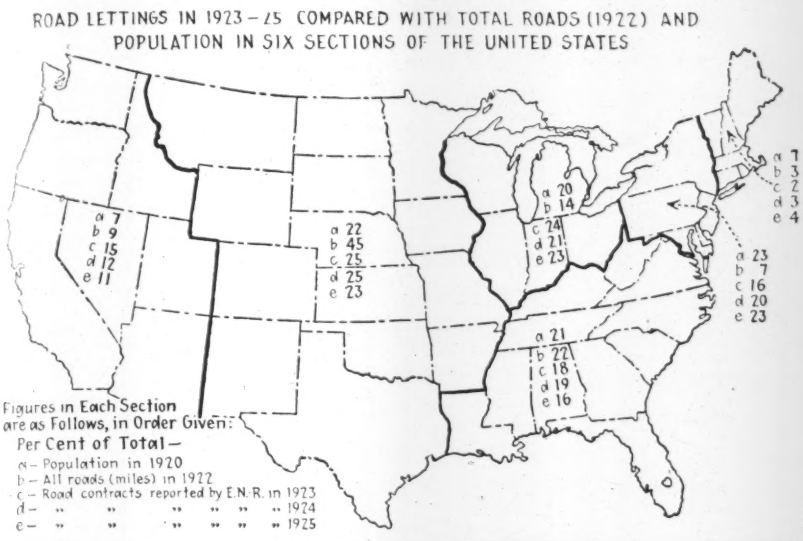
1913	$58,407,000	1920	$262,640,000
1914	72,818,000	1921	313,302,000
1915	78,037,000	1922	334,694,000
1916	156,937,000	1923	361,837,000
1917	103,365,000	1924	415,216,000
1918	73,793,000	1925	422,054,000
1919	225,654,000		

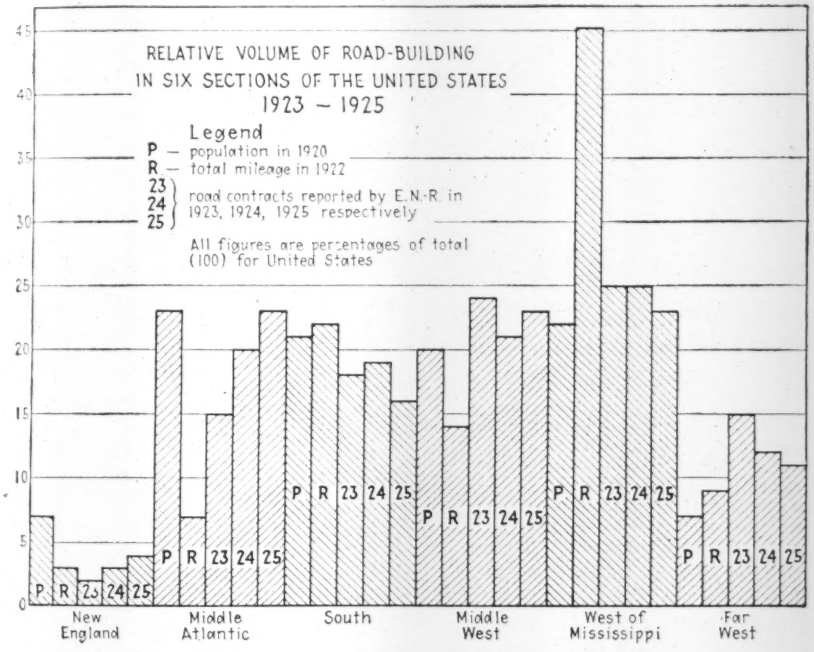
Over 88 per cent of all projects reported in any month as definitely proposed are under contract within three months, according to a recent analysis of construction statistics conducted by *Engineering News-Record*, hence, the prediction that the first quarter of 1926 will see an increase in number of street and road projects, consistent with the seasonal trend. Comparing street and road contracts let during December, 1925 with those of the same month last year, we find decided gains in the following states: Massachusetts, Rhode Island, New York, Pennsylvania, West Virginia, North and South Carolina, Florida, Mississippi, Kentucky, Tennessee, Illinois, Wisconsin, Arkansas, Washington, and California. Compared with the preceding month, however, there were marked increases in the following states: Massachusetts, Rhode Island, New York, Alabama, Mississippi, Tennessee, Wisconsin, Missouri, Washington, and California.

The accompanying map shows the trend of street and road lettings by sections, that is, the percent of total mileage and value of paving contracts for the entire United States, awarded in each section in relation to its population.

The report of the Chief of the Bureau of Public Roads to the U. S. Department of Agriculture for the fiscal year 1925 contains the following: "By completing 11,328.6 mi. of Federal-aid roads during the fiscal year 1925, the co-operating Federal and State governments established a new record. The greatest mileage previously completed in any one fiscal year was the 10,247 mi. completed in 1922. The new record exceeds by 30 per cent the mileage completed in the fiscal year 1924, and by more than 50 per cent the aggregate mileage completed during the first five years of work under the Federal-aid plan.

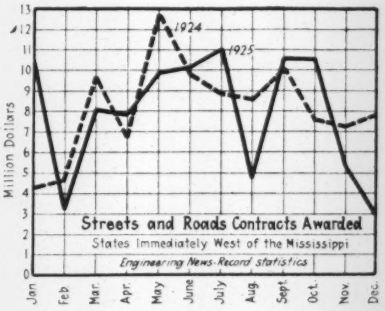
"The year's work brings the total of mileage completed since the passage



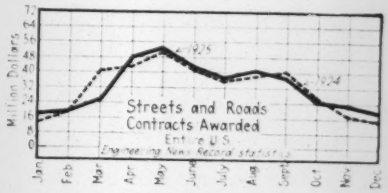

RELATIVE VOLUME OF ROAD-BUILDING
IN SIX SECTIONS OF THE UNITED STATES
1923 – 1925
Legend
P – population in 1920
R – total mileage in 1922
23, 24, 25 } road contracts reported by E.N.-R. in 1923, 1924, 1925 respectively
All figures are percentages of total (100) for United States
New England
Middle Atlantic
South
Middle West
West of Mississippi
Far West

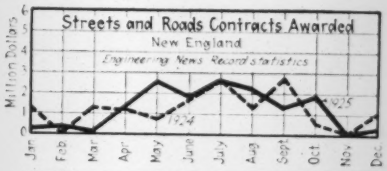
CONTRACT FIGURES USED IN TWO ILLUSTRATIONS ABOVE REPRESENT THOSE AWARDED IN FIRST ELEVEN MONTHS OF EACH YEAR

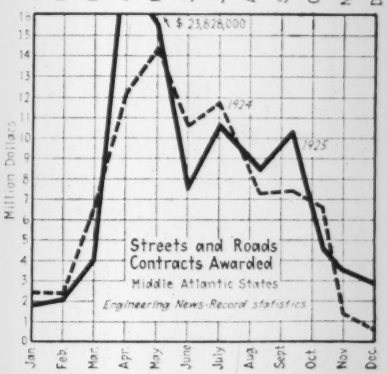
of the first Federal-aid road act in 1916 up to 46,485.5 mi.; and in addition to the mileage completed a great deal of work has been done on the 12,462.6 mi. which at the close of the year were under construction. The program of work thus far undertaken includes the above mileage completed and under construction and an additional 2,181.6 mi. approved for improvement with Federal aid but not yet placed under construction. Including this latter mileage the program of Federal and State co-operation in road building as definitely planned or completed to date involves 61,129.7 mi., of which all but 3,570 mi. undertaken prior to the passage of the Federal highway act in 1921 are included in the interstate or Federal-aid highway system designated in accordance with the provisions of that act."

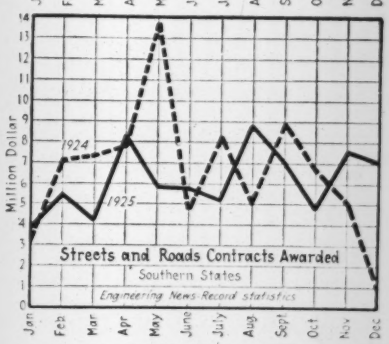

Million Dollars
1924
1925
Streets and Roads Contracts Awarded
States Immediately West of the Mississippi
Engineering News-Record statistics
Jan Feb Mar Apr May June July Aug Sept Oct Nov Dec

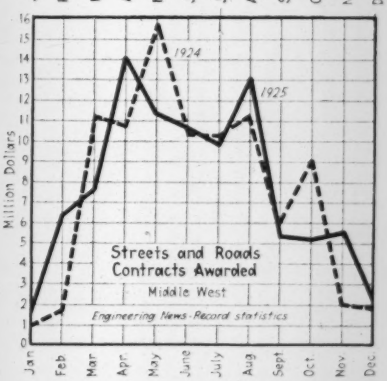
A tabulation showing prices of road surfacing materials in the current market compared with a year ago, appears on p. 44. Most of the materials show no change; the ratio of advances to declines is about 7 to 4.

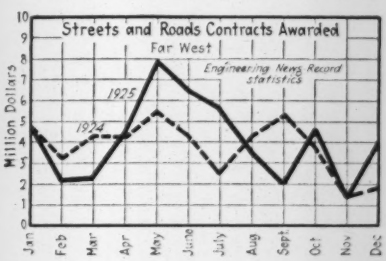












No Serious Advances In 1926 Building Trades Wage Schedules Likely

Skilled Mechanics Average Rate for 1925 Considerably Above Preceding Year—Common Laborers Get Less

FURTHER disturbance of existing wage schedules in the building trades, in most of the large centers throughout the country, appears unlikely at the present time, with the possible exception of New York City.

The Board of Governors of the Building Trades Employers' Association of New York City met yesterday to consider the demands of building trades mechanics for an increase of $1, with a possible further rise of 50c. per day, as the wage schedule for 1926.

These demands, if granted, may have a disturbing effect upon the building crafts in other cities where tranquility now prevails.

Philadelphia reports a strike of stone cutters and trouble with bricklayers, electrical and sheet metal workers but owing to unemployment in excess of the seasonal let-down nothing serious is indicated. Dallas and Pittsburgh both anticipate wage demands on the part of building trades mechanics but no actual strikes are in sight. Cleveland painters demand a five-day week and an advance in wages, threatening to strike Mar. 1 unless terms are met.

Comparing the current building trades wage situation with that of a year ago, we find that with few exceptions the general level for skilled mechanics is higher. The 1925 average was also considerably above that of the year preceding in the case of skilled workers, while the common laborers' rate remained below the 1924 average from February, 1925 to the end of the year.

A comparison of present rates with those obtaining Jan. 1, 1925, shows that bricklayers, for instance, are receiving 12½c. per hr. more than a year ago in Dallas, Minneapolis and Seattle, and 7½c. in Pittsburgh. In Kansas City, Mo. the rate is 12½c. lower and down 10c. per hr. in Montreal. In the other fifteen cities there was no change of schedule.

Carpenters received no wage reductions in any of the cities covered and gained instead, advances of 12½c. per hr. in Birmingham, Chicago, Dallas, and Seattle. There was also a slight increase in this trade at Minneapolis.

Hoisting engineers receive 12½c. per hr. more than at this time last year in Chicago and 6¼c. per hr., in Pittsburgh. The rate is lower by 5c. in Boston, 5¾c. in Montreal and 2½c. per hr. in St. Louis. Los Angeles increased wages in this trade as much as 25 per cent.

The hod carriers' rate is up 25c. per hr. in Birmingham and 2½c. in Kansas City, Mo.; Boston, Los Angeles and Chicago dropped approximately 12½c. per hr. in the remuneration of bricklayers' helpers.

Pile drivers get 12½c. more per hr. in Chicago than a year ago, while the wage rate in this occupation is higher by 5c. per hr. in Boston and New Orleans. Los Angeles reduced pile drivers' wages 12½c. per hour.

Structural iron workers received advances in eleven out of twenty-one cities, comparing the present schedules with those in effect Jan. 1, 1925. Chicago, Cleveland, Kansas City, Mo., Los Angeles, New Orleans, and Philadelphia are all 12½c. per hr. above last years rates, while Pittsburgh shows an increase of 6¼c., Montreal, 15c., New York, 18¾c. and Birmingham, 50c. per hr. The Boston rate is down 15c. per hour.

Common laborers may be defined as pick and shovel or clean-up men in construction operations. The rate for this grade of labor is 5c. per hr. higher in Pittsburgh and Chicago, 8c. in Boston and 22½c. per hr. in St. Louis. The decline at Philadelphia amounts to about 5c. and in Detroit, 15c. per hr., compared with a year ago.

Price Declines Slightly in Excess of Advances Compared with Year Ago

Clay Drain Tile, Pine Piles and Wire Rope at January, 1925 Levels—Steel Pipe and Standard Rails Unchanged Since 1922

A COMPARISON of prices on forty-two basic construction materials with those prevailing at this time last year, shows declines slightly in excess of advances, while very nearly as many materials remained unchanged as showed increases in cost.

Advances occurred in re-rolled rails, track bolts, cast-iron pipe, hollow tile, lumber, sheetpiling, manila rope, road and paving materials.

Declines were shown in iron and steel scrap, white oak ties, standard railroad spikes, sewer pipe, lump lime, reinforcing bars, structural shapes, wire and cut nails, roofing, window glass, steel sheets, linseed oil, red and white lead, water and sewage treatment chemicals (except soda ash), brick aggregates, and cement. The various materials taken separately, are as follows: Pig iron shows very little change from a year ago levels. Iron and steel scrap declined in Chicago and Birmingham but showed no definite change in New York. Standard rails have not changed in price since 1922. Light rails are the same as a year ago. White oak ties, 6 in. x 8 in. x 8 ft., are down 25c. compared with a year ago, in the Chicago market. San Francisco, St. Louis and Birmingham show no change. Standard railroad spikes declined 10c., while track bolts are 15c. per 100 lb. higher at Pittsburgh mill. Standard section angle bars did not change at mill. Steel pipe prices are the same as in 1922. Cast-iron pipe, however, is $1 to $2 per ton higher than a year ago at Birmingham. Clay drain tile (3-in.), pine piles, and wire rope are unchanged from a year ago. Sewer pipe (6-in.) is lower by about one cent per foot at factory. Common lump lime shows an average drop of 20c. per bbl. throughout the country. Expanded metal lath is the same price as at this time last year in four out of five cities. Steel sheetpiling is 25c. per 100 lb. higher at Pittsburgh mill. Manila rope averages 5c. per lb. above the January, 1925 price throughout the country. The few changes in prices of explosives are mostly declines. An average price of cement at sixteen mills throughout the country shows a drop of 7c. per bbl. compared with this time last year. Desirable tonnages of reinforcing bars can be purchased at about 10c. per 100 lb. under prices of a year ago at Pittsburgh mill. Brick showed an average decline of 70c. per M. throughout the country. Hollow tile is about 1c. per block higher at factory. Structural shapes sell at 15c. per 100 lb. under the January, 1925 level at Pittsburgh mill. Ship spikes and structural rivets remain unchanged. Wire nails are down 20c. and cut, 10c. per base keg. Steel sheet quotations are 15 to 25c. per 100 lb., linseed oil, 23¼c. per gal., red and white lead, 50c. per 100 lb., below a year ago. Roofing and roofing materials are considerably below prices in effect last year at this time and heavier discounts are being granted on window glass. The average wholesale advance in lumber is $1.25 per M. ft. b.m.

ROAD AND PAVING MATERIALS
Carload Lots to Contractors, F.O.B.

	Current	Year Ago
Road oils, 45% asphalt, per gal.		
New York	$0.065@$0.07	$0.07
St. Louis	.0525	.0475
Dallas	.0495	.0495
Asphalt, per ton, package		
New York	23.00	23.00
Kansas City, Mo.	27.30	27.30
Dallas	27.10	27.10
Paving stone, 5-in., granite, per M.		
New York	147.00	135@142
Boston	135.00	132.00
Cincinnati	135.00	135.00
Flagging, 4-ft., per sq.ft.		
New York	.24	.22
Curbing, 5x16-in., per lin.ft.		
New York	.88	.85
Wood block paving, size 3, 16 treatment, per sq.yd.		
New York	2.40	2.39
New Orleans	2.20	2.20
Detroit	1.94	1.94
Sand, per cu.yd.		
New York	1.00	1.25
Minneapolis	1.25	1.25
San Francisco	1.50	1.50
Gravel, ¾-in., per cu.yd.		
New York	1.75	2.25
Minneapolis	1.65	1.65
San Francisco	2.15	2.15
Crushed stone, ¾-in., per cu.yd.		
New York	1.85	1.85
Minneapolis	1.75	1.75
San Francisco	2.15	2.15
Cement, per bbl., net, average of sixteen mills throughout the country	1.93	2.00
Triangle mesh, paving, 4x4-in. mesh, 17 lb., per 100 sq.ft.		
Pittsburgh	0.74	0.74
Paving brick 3x8½x4-in., per M.		
Philadelphia	40.00	38.00
Chicago	42.00	50.00

E. N.-R. Prices of Construction Materials

Price advances since last month are indicated by **heavy type**; declines by *italics*

PIG IRON—Per Gross Ton f.o.b.:

	Jan. 7	One Year Ago
CINCINNATI		
No. 2 Southern (silicon 2.25@2.75)	$24.05	$24.05
Northern Basic	24.27	22.77
Southern Ohio No. 2 (silicon 1.75@2.25)	24.27	22.77
NEW YORK, tidewater delivery		
Southern No. 2 (silicon 2.25@2.75)	28.37	30.25
BIRMINGHAM		
No. 2 Foundry (silicon 2.25@2.75)	23.00	20.00
PHILADELPHIA		
Eastern Pa., No. 2X (2.25@2.75 sil.)	24.16	24.26
Virginia No. 2 (silicon 2.25@2.75)	29.17	30.17
Basic	23.16	23.26
CHICAGO		
No. 2 Foundry Local (silicon 1.75@2.25)	23.00	22.00
No. 2 Foundry Southern (silicon 2.25@2.75)	26.55	25.55
PITTSBURGH, including freight charge ($1.76) from the Valley		
No. 2 Foundry Valley (silicon 1.75@2.25)	22.27	23.77
Basic	22.27	23.77
Bessemer	22.27	23.77

SCRAP—The prices following are f.o.b. per ton paid by dealers:

	New York	Chicago	Birmingham
No. 1 railroad wrought	*$14.75*	*$14.00@$14.50*	$13.00@$13.50
Stove plate	*14.50*	*15.00@15.50*	14.00@14.50
No. 1 machinery cast		*17.25@17.75*	17.00@17.50
Machine shop turnings	**11.25**	*9.50@10.00*	8.00@8.50
Cast borings	*12.25*	*11.75@12.25*	8.00@8.50
Railroad malleable	17.00	*16.00@16.50*	17.00@**18.00**
Re-rolling rails	14.75	*16.00@16.50*	16.50@17.00
Re-laying rails	23.50		21.00@22.00
Heavy melting steel	*12.75*	*13.50@14.00*	

Railway Supplies

STEEL RAILS—The following quotations are per ton f.o.b. for carload or larger lots. For less than carload lots 5c. per 100 lb. is charged extra:

	Pittsburgh Jan. 7	Pittsburgh One Year Ago	Birmingham	Chicago	St. Louis
Standard bessemer rails	$43.00	$43.00	$43.00	$43.00	$47@49
Standard openhearth rails	43.00	43.00	43.00	43.00	49@50
Light rails, 8 to 10 lb.		36@38	34@36	1.80@1.90	
Light rails, 12 to 14 lb.	36@38	36@38	34@36	1.80@1.90	1.90@1.95*
Light rails, 25 to 45 lb.	36@38	36@38	34@36	1.80@1.90	1.85@1.90*
Re-rolled rails	**33@35**	27@30			

*Per 100 lb.

RAILWAY TIES—For fair-sized orders, the following prices per tie hold:

	6 In. x 8 In. by 8 Ft.	7 In. x 9 In. by 8½ Ft.
Chicago, white oak, plain	*$1.35*	*$1.65*
Chicago, empty cell creosoted	*1.70*	*2.00*
Chicago, zinc treated	*1.50*	*1.80*
San Francisco, green Douglas fir	.84	1.14
San Francisco, empty cell creosoted, Douglas fir	1.70	2.25
St. Louis, white oak, plain	**1.20**	**1.45**
St. Louis, zinc treated	**1.60**	**1.85**
St. Louis, red oak, plain	**1.10**	**1.35**
St. Louis, sap pine-cypress	**.95**	**1.20**
Birmingham, white oak	1.25	1.45

TRACK SUPPLIES—The following prices are base per 100 lb. f.o.b. Pittsburgh mill for carload lots, together with the warehouse prices at the places named:

	Pittsburgh Jan. 7	Pittsburgh One Year Ago	Chicago	St. Louis	San Francisco	Birmingham
Standard spikes, ⅝-in. and larger	*$2.80*	$2.90	$3.55	3.65@3.75	$4.35	$2.90@**3.00**
Track bolts	3.90@4.15	3.75@4.00	4.55	4.25@4.35	5.85	**3.90**
Standard section angle bars	2.75	2.75	3.40	3.25@3.75	4.00	@**4.15** **3.85**

Pipe

WROUGHT PIPE—The following discounts are to jobbers for carload lots at Pittsburgh mill:

Inches	Steel Black	Steel Galv.	Inches	Iron Black	Iron Galv.
BUTT WELD					
1 to 3	62	50½	1 to 1¼	30	13
LAP WELD					
2	55	43½	2	23	7
2½ to 6	59	47½	2½	26	11
7 and 8	56	43½	3 to 6	28	13
9 and 10	54	41½	7 to 12	26	11
11 and 12	53	40½			
BUTT WELD, EXTRA STRONG, PLAIN ENDS					
1 to 1½	60	49½	1 to 1½	30	14
2 to 3	61	50½			
LAP WELD, EXTRA STRONG, PLAIN ENDS					
2	53	42½	2	23	9
2½ to 4	57	46½	2½ to 4	29	15
4½ to 6	56	45½	4½ to 6	28	14
7 and 8	52	39½	7 and 8	21	7
9 and 10	45	32½	9 to 12	16	2
11 and 12	44	31½			

STEEL PIPE—From warehouses at the places named the following discounts hold for welded steel pipe:

	Black New York	Black Chicago	Black Birmingham	Black St. Louis
1 to 3 in. butt welded	53%	54%	62%	49%
2½ to 6 in. lap welded	48%	51%	59%	46%
	Galvanized New York	**Galvanized** Chicago	**Galvanized** Birmingham	**Galvanized** St. Louis
1 to 3 in. butt welded	39%	41%	50½%	36%
2½ to 6 in. lap welded	35%	38%	43½%	33%

Malleable fittings, Classes B and C, banded, from New York stock sell at list plus 4% less 5%. Cast iron, standard sizes, 30 to 35% off.

CAST-IRON PIPE—The following are prices per net ton for carload lots:

	Birmingham	Burlington, N. J.	New York Jan. 7	New York One Year Ago
4 in.	$45.00	$53.00@$54.00	$55.60@56.60	$60.60@61.60
6 in. and over	41.00@**42.00**	**49.00**@50.00	**51.60**@52.60	55.60@56.60
	Pittsburgh	**Chicago**	**St. Louis**	**San Francisco**
4 in.	**$53.20@54.20**	$53.20@54.20	$52.00	*$55.00*
6 in. and over	**49.20@50.20**	50.20@**51.20**	48.00	*51.00*

Gas pipe and Class "A," $4 per ton extra.

CLAY DRAIN TILE—The following prices are per 1,000 lin.ft.:

Size, In.	New York Jan. 7	New York One Year Ago	St. Louis	Birmingham	San Francisco	Dallas
3	$48.00	$48.00	$40.00	$45.00		$73.00
4	60.00	50.00	40.00	56.00	$76.50	110.00
5				80.00	97.75	118.00
6	90.00	92.00	70.00	100.00	127.50	150.00
8	160.00	160.00	170.00	165.00	212.50	210.00

SEWER PIPE—The following prices are in cents per foot for standard pipe in car load lots, f.o.b., except as otherwise stated:

Size, In.	New York Delivered	Pittsburgh	Birmingham	St. Louis	Chicago	San Francisco	Dallas
3		$0.081	$0.10		$0.09	$0.12	
4		.081	.10	$0.10	.09	.15	$0.15
5		.1215	.135		.13½	.18	.18
6	$0.21	.1215	.135	.14	.13½	.21	.21
8	.35	.189	.21	.225	.21	.30	.325
10	.52	.2835	.315	.315	.31½	.42	.476
12	.66	.3645	.45	.405†	.40½	.56	.612
15	1.14†	.486	.54	.675†	.54	.92	1.02
18	1.65†	.675	.75	.945†	.75	1.32	1.53
20	1.98†	.81	.90	1.26†	.90		
22	2.65†	1.08	1.20		1.20		1.564
24	2.97†	1.215	1.35	1.62†	1.35	2.16	2.04
27	4.65†	2.405	2.665	2.45†	2.75	3.00	3.34
30	5.16†	2.664	2.952	3.00†	3.75	3.60	4.06
33	6.98†	3.60	3.96	3.55†	4.50		4.99
36	8.00†	4.10	4.51	3.95†	5.00		5.42

	3	5	8	12	24	36
Boston	$0.13	$0.20	$0.30	$0.60	$2.00†	$5.50†
Minneapolis			.225	.405	1.35	4.75
Denver	.135*	.18*	.27	.47	1.70	
Seattle	.14		.35	.72†	2.60†	
Los Angeles	.1625	.195	.275	.495	1.65	
New Orleans	.115*	.117*	.295	.4725	1.575	
Cincinnati	.105	.1575	.245	.4725	1.575	4.715
Atlanta	.10*	.15*	**.25**	**.425**	**1.625**	
Montreal	.68‡	.45†	.70	1.35	4.50†	
Detroit	.11	.1665	.259	.4995	2.25†	7.175†
Baltimore	**.111**	.166	.259	.499	1.665	4.92
Kansas City, Mo.	**.15**	**.21**	**.33½**	.52	2.16	
Philadelphia	.11	.17	.26	.50	1.67	3.80

*4-in., 6-in., 9-in., respectively. †Double Strength. ‡3-in. special.

Road and Paving Materials

ROAD OILS—Following are prices per gallon in tank cars, 8,000 gal. minimum f.o.b. place named:

	Jan. 7	One Year Ago
New York, 45% asphalt (at terminal)	$0.065@$0.07	$0.07
New York, 65% asphalt (at terminal)	.0675@.0725	.0725
New York, binder (at terminal)	.07 @ .075	.075
New York, flux (at terminal)	.07 @ .075	.075
New York, liquid asphalt (at terminal)	.07 @ .075	.075
St. Louis, 40@50% asphalt	.05½	.0475
St. Louis, 50@60% asphalt	.05½	.0481
Birmingham, 55% asphalt	.0475	.0465
Dallas, 45% asphalt	.0495	.0495
Dallas, 55% asphalt	.0455	.0455
Dallas, binder	.061	.061
San Francisco, binder, per ton	12.00*	11.00*

* F.o.b. Oleum, Cal. Freight to San Francisco, 80c. per ton.

E. N.-R. Prices of Construction Materials

ASPHALT—Price per ton in packages (350-lb. bbls. or 425-lb. drums) and in bulk in carload lots, f.o.b. points listed:

	Package	Bulk
New York (*Texas*)	$23.00*	$18.50
Boston (*Mexican*)	22.50	18.50
Chicago (*Texas*)	27.00	23.00
San Francisco, *f.o.b. refinery*, Oleum, Cal.	18.00	12.00
Dallas (*Texas*)	27.10	21.10
Seattle, "D" *grade, California, f.o.b. Richmond*	19.50	13.50
Denver (*California*)	24.00	...
Minneapolis, *f.o.b. Twin Cities (Standard)*	27.60	21.60
St. Louis (*Mexican*)	25.00	21.00
Baltimore (*Mexican*) (*f.o.b. refinery*)	22.50	18.50
Montreal (*Imperial*)	28.00	21.00
Atlanta (*Mexican*)	24.60	20.40
Detroit (*Mexican*)	27.00	23.00
Cincinnati (*Kentucky Rock*)	...	11.65
Maurer, N. J. (*Bermudez*)	30.00	...
Maurer, N. J. (*Trinidad*)	23.00	...
Philadelphia (*Mexican*)	24.00	22.00
Kansas City, Mo. (*Texas*)	27.30	22.30
Los Angeles ("D" *grade, California*)	†18.00	†12.00
Birmingham (*Mexican*)	27.00	21.00
New Orleans (*Mexican*)	26.00	17.00

* In drums. † f.o.b. El Segundo Refinery.

NOTE—Barrels or drums are optional in most cities. About 6 bbls. to the ton, and from 4 to 5 drums, 200 to 300 gal. to the ton.

PAVING STONE—

New York (grade ft. 5-in. granite, 30 blocks per sq.yd.		$147.00 per M.
San Francisco	Basalt block 4x7x8	70.00 per M.
Chicago	about 5x8x5 dressed	3.60 per sq.yd.
	about 5x8x5 common	3.25 per sq.yd.
Boston	5-in. Granite	135.00 per M.
Atlanta	Granite	2.50 per sq.yd.
Detroit	5-in. Granite	3.00 per sq.yd.
Baltimore	Granite	2.85 per sq.yd.
Montreal	Granite	104.75 per M.
New Orleans	Granite, 4x8x4	3.18 per sq.yd.
Cincinnati	Granite	135.00 per M.
St. Louis	Granite, 4x8x4	1.65 per sq.yd.
Kansas City	Granite	4.00 per sq.yd.
Philadelphia	Granite	3.90@4.25 per sq.yd.
Minneapolis	Sandstone	2.74 per sq.yd.

FLAGGING—

New York	Bronx, 4 ft. wide	$0.24 per sq.ft.
	Manhattan, 4 ft. wide	.24 per sq.ft.
	Queens, 5 ft. wide	.26 per sq.ft.
	6x24-in. cross-walk	1.30 per lin.ft.

CURBING—*New York*: Bluestone per lin.ft., f.o.b. barge New York, 5x16 in., 88c.; *St. Louis*: Class "A" straight, delivered, 5x18 in., $1.05 per lin.ft.; round-ings, $1.60. *Birmingham*: Limestone, 5x18-in., $1.05 per lin.ft.

WOOD BLOCK PAVING—

	Size of Block	Treatment	Per Sq.Yd.
New York	3	16	$2.40
New York	3½	16	2.70
Boston	3½	18	2.50
Chicago	4	16	2.25
Chicago	3½	16	2.10
St. Louis	3½	16	2.40
St. Louis	4	16	2.70
Seattle	4	16	Off market
Minneapolis	3½	16	2.49
Atlanta	3½	16	2.00
New Orleans	3	16	2.20
New Orleans	3½	16	2.30
New Orleans	4	16	2.40
Dallas	4	18	3.90
Baltimore	3½	16	None used
Montreal	4	16	4.50
Detroit	3	16	1.94
Detroit	4	16	...
Cincinnati	3½	16	2.35
Kansas City	4	16	3.75
Philadelphia	4	16	None used

Construction Materials

SAND AND GRAVEL—Price for cargo or carload lots to contractor f.o.b., per cu.yd. is as follows:

	Gravel				Sand	
	1½ In.		¾ In.			
	Jan. 7	One Year Ago	Jan. 7	One Year Ago	Jan. 7	One Year Ago
New York (*Class of bidder*)	$1.75	$2.25	$1.75	$2.25	$1.00	$1.25
Denver	1.90	1.90	1.90	1.90	1.00	1.00
Chicago	**1.65**	...	**1.65**	...	**1.50**	...
St. Louis	1.45	1.45†	1.45	1.45†	1.08	1.18†
Seattle	1.50	1.50	1.50	1.50	1.50	1.50
Dallas	2.38	2.38	2.38	2.38	2.00	2.00
Minneapolis	1.65*	1.65*	1.65*	1.65*	1.25	1.25
Cincinnati	1.40†	1.40†	1.40†	1.40*	1.35†	1.35†
San Francisco	2.15	2.15	2.15	2.15	1.50	1.50
Boston	1.50†	1.50†	1.50†	1.50†	1.00†	1.00†
New Orleans	2.50	2.63	2.60	2.63	1.75	1.75
Los Angeles	.85*†	1.50†	.85*†	1.55†	.50*†	1.10†
Atlanta	1.50†	1.90†	1.90†	1.90†	1.50†	1.40†
Detroit	2.02	2.02	2.02	2.02	1.62	1.62
Baltimore	1.40	1.40	1.60	1.60	.70*†	.70*†
Montreal	1.25†	1.25†	1.25†	1.25†	1.25†	1.25†
Birmingham	2.00	2.00	2.00	2.00	1.50	1.45†
Philadelphia	2.10	2.10	2.10	2.10	1.50	1.50
Kansas City	4.00‡	4.00†	4.00†	4.00‡	.56*†	.66*†

New York—Grits, $1.75 per cu.yd.; ready mixed $1.85. †Joplinchat.
Los Angeles—Freight from quarry, 70c. per ton, and is included in above price.
* At pit. † Per ton.

CRUSHED STONE—Price for cargo or carload lots, per cu.yd. f.o.b. city, as follows:

	1½ In.		2 In.	
	Jan. 7	One Year Ago	Jan. 7	One Year Ago
New York	$1.75	$1.75	$1.85	$1.85
Chicago	**1.75**		1.87½	
St. Louis*	1.93*	1.75*	1.93*	1.75
Dallas	2.40	2.40	2.83	2.83
San Francisco	2.15	2.15	2.15	2.15
Boston	1.60*	1.60*	1.60*	1.60*
Minneapolis	1.75	1.75	1.75	1.75
Kansas City	1.50	1.50	1.50	1.50
Denver	2.50	2.50	2.50	2.50
Seattle	3.00	3.00	3.00	3.00
Atlanta	2.10*	2.00*	2.10*	2.00*
Cincinnati	1.90*	1.90*	1.90*	1.90*
Los Angeles	1.00*	1.65*	1.00*	1.75*
Detroit	2.00*	1.70	2.00*	1.70
Baltimore	2.50	2.50	2.55	2.55
Montreal	1.80*	1.80*	1.50*	2.25*
Philadelphia	2.10	2.10	2.10	2.10
Pittsburgh	2.85	2.95	2.85	2.85
Cleveland	3.25*	3.25*	3.25*	3.25*
Birmingham	2.00	2.00	2.00	2.00

* Per ton.

CRUSHED SLAG—Price of crushed slag in carload lots, per net ton, at plant:

	1½-In.	¾-In.	Roofing	Sand
Youngstown District	**$1.30**	**$1.40**	$2.00	**$1.30**
Steubenville District	1.25	1.30	2.00	1.30
Ironton District	1.40	1.40	2.00	1.40
Easton, Catasauqua, Pa.	...	...	2.50	...
Birmingham, Ala.	.80@.90	1.15	2.05	...
Buffalo, N. Y., and Erie, Pa.	1.25	1.25	2.25	1.25
Cleveland, Ohio	1.30	1.30	1.30	1.30
Eastern Pa. and Northern N. J.	1.25	1.25	2.50	1.25
Western Pennsylvania	1.25	1.25	2.00	1.25
Longdale and Glen Wilton, Va.	1.25	1.25	2.50	...
Toledo, Ohio	1.25	1.25	1.50	1.25

LIME—Warehouse prices:

	Hydrated, per Ton		Lump, per Barrel	
	Finishing	Common	Finishing	Common
New York	$18.20	$12.00@$13.10	$3.50*	$1.25@2.75*
Chicago	20.00	18.00	...	1.30‡
St. Louis	24.00	20.00	15.00‡	15.00‡
Boston	20.00	13.50@14.50	3.75*	3.00*
Dallas	20.00	...	...	1.85‡
Cincinnati	16.80	14.30	...	13.40‡
San Francisco	22.00	...	...	1.60‡
Minneapolis	25.50	21.00	1.50@1.70†	(brown) 1.35‡
Denver	24.00	...	...	2.70*
Detroit	15.50	12.50	...	16.00‡
Seattle, *paper sacks*	24.00	...	2.80†	...
Los Angeles	25.00	18.00	3.50	19.50‡
Baltimore	24.25	17.85	2.55†	...
Montreal	...	21.00	...	10.00‡
Atlanta	22.50	13.00	**2.20†**	**1.50‡**
New Orleans	24.00	16.00	2.50†	2.00*
Philadelphia	23.00	16.00	...	...
Kansas City	17.50	15.00	2.24*	...
Birmingham	22.50	16.00	2.40†	1.85†

* Per 280-lb. bbl. (net). † Per 180-lb. (net). ‡ Per ton.

NATURAL CEMENT—Price to dealers per bbl. for 500 bbl. or over, exclusive of bags:

	Jan. 7	One Year Ago
Minneapolis (Rosendale)	$2.80	$2.80
Kansas City (Ft. Scott)	1.35	1.50
Cincinnati (Utica)	1.72	1.72
Boston (Rosendale)	2.65	2.50
St. Louis (Carney)	2.50	2.35
Birmingham (Magnolia) pozzolan cement	2.40	2.25

PORTLAND CEMENT—Prices to contractors per bbl. in carload lots f.o.b. points listed *without bags*. Cash discount not deducted.

	Jan. 7	One Month Ago	One Year Ago
New York, del. by truck	$2.50@2.70	$2.50@2.70	$2.50@2.60
New York, alongside dock to dealers	2.15	2.15	2.15
Jersey City	2.33	2.33	2.33
Boston	2.40	2.40	2.67½
Chicago	2.10	2.10	2.10
Pittsburgh	2.09	2.09	2.19
Cleveland	2.29	2.29	2.39
Detroit	2.15	2.15	2.40
Indianapolis	2.29	2.29	2.31
Milwaukee	2.25	2.25	2.25
Duluth	2.09	2.09	2.19
Peoria	2.27	2.27	2.27
Cedar Rapids	2.34	2.34	2.38
Davenport	2.29	2.29	2.29
St. Louis	2.20	2.20	2.20
San Francisco	2.31	2.31	2.61
New Orleans	2.40	2.40	2.40
Minneapolis	2.32	2.32	2.42
Denver	2.84	2.84	2.84
Seattle	2.65	2.65	2.65
Dallas	2.05	2.05	2.05
Atlanta	2.30	2.25	2.35
Cincinnati	2.37	2.37	2.37
Los Angeles	2.52	2.52	2.60
Baltimore	2.50	2.50	2.50
Birmingham	2.40	2.40	2.40
Kansas City, Mo.	2.40	2.30	2.07
Montreal	1.80	1.80	1.80
Philadelphia	2.60	2.41	2.41
St. Paul	2.32	2.32	2.42
Toledo	2.20	2.20	2.36

NOTE—Bags 10c. each, 40c. per bbl.; 20c. each in Canada, 80c. per bbl.

Current mill-prices per barrel in carload lots, without bags, to contractors:

Buffington, Ind.	$1.85	Hudson, N. Y.	$2.05
Universal, Pa.	1.85	Leeds, Ala.	1.95
Steelton, Minn.	1.90	Hannibal, Mo.	1.95
Fordwick, Va.	2.05	Lehigh Valley District	1.95
Mitchell, Ind.	1.95	Wyandotte, Mich.	1.90
Iola, Kan.	1.95	Alpena, Mich.	1.75
Mason City, Ia.	1.90	Richard City, Tenn.	2.05
La Salle, Ill.	1.95	Kingsport, Tenn.	2.05

E. N.-R. Prices of Construction Materials

TRIANGLE MESH—Price per 100 sq.ft. in carload lots:

PLAIN 4-INCH BY 4-INCH MESH

Style Number	Weight in Pounds per 100 sq.ft.	Pittsburgh Mill	Chicago District Mill	Warehouse: New York	St. Louis	Dallas	San Francisco
032	22	$0.97	$1.01	$1.39	$1.06	$1.13	$1.22
049	28	1.23	1.29	1.76	1.35	1.38	1.55
068	35	1.51	1.58	2.16	1.66	1.67	1.91
093	45	1.94	2.03	2.77	2.13	2.00	2.46
126	57	2.39	2.51	3.45	2.63	2.55	3.03
153	68	2.86	2.99	4.11	3.14	3.15	.....
180	78	3.28	3.43	5.70	3.60	3.47	.....
245	103	4.33	4.53	6.21	4.75	4.58	.....
287	119	5.00	5.24	7.19	5.50	5.26	6.35
336	138	5.80	6.07	8.35	6.37	6.11	.....
395	160	6.72	7.04	9.65	7.38	7.12	.....
		PAVING					
036P	17	$0.74	$0.77	$1.06	$0.81	$0.76	.....
053P	24	1.04	1.09	1.50	1.14	1.07	.....
072P	31	1.32	1.38	1.90	1.45	1.39	.....
097P	40	1.70	1.78	2.45	1.87	1.90	.....
049R	24	1.04	1.09	.....	1.14	1.07	.....
067R	31	1.32	1.38	.....	1.45	1.39	.....
089R	40	1.70	1.78	.....	1.87	1.90	.....

In rolls, 48-, 52-, and 56-in. wide and in 150-, 200- and 300-ft. lengths. Galvanized is about 15% higher. Size of roll carried in New York warehouses, 48 in. wide x 150 ft. long, or 600 sq.ft.

EXPANDED METAL LATH—Prices in carload lots per 100 yd. for painted:

Weight in pounds	New York	Birmingham	Chicago	St. Louis	San Francisco	Dallas
2.2	$19.00	$22.00	$19.00	$19.00	$24.00	$23.50
2.5	21.00	23.00	21.00	21.00	26.00	25.00
3.0	24.00	26.00	24.00	24.50	30.00	28.50
3.4	26.00	28.00	26.00	26.50	33.00	31.00

BARS, CONCRETE REINFORCING—Current quotations per 100 lb.:

ROLLED FROM BILLETS

Inches	Pittsburgh Mill	Birmingham	Warehouse, Uncut: New York	Chicago	St. Louis	Dallas	San Francisco
½ and larger	$2.00@$2.10	$2.25	$3.24	$3.00	$3.15@3.25	$3.38	$3.35
⅝	2.10@2.20	2.35	3.34	3.10	3.25@3.35	3.43	3.45
¾	2.20@2.30	2.45	3.44	3.20	3.35@3.45	3.48	3.55
⅞	2.40@2.50	2.65	3.64	3.40	3.55@3.65	3.63	3.75
1	3.00@3.10	3.25	4.24	4.00	4.15@4.25	3.78	4.35

For standard classification of extras for size and cutting of steel bars, see bar card of July 15, 1923.

ROLLED FROM RAILS

	St. Louis	Dallas		St. Louis	Dallas
½ and larger	$2.55@2.65	$2.80	⅝	$2.95@3.05	$3.02
¾ in.	2.75@2.85	2.85	1	3.55@3.65	3.50
1	2.85@2.95	2.90			

BRICK—Contractors price per 1,000 in cargo or carload lots is as follows:

	Common: Jan. 7	One Month Ago	One Year Ago	Paving Block: 3-inch*	3½-inch*
New York (del.)	$18.50	$17.50@19.50	$18.00	$45.00	$51.00
New York (at dock)	15.25	14.50@16.50	15.00	.....	.....
Chicago	12.00	12.00	12.00	42.00	45.00
St. Louis, salmon (del.)	16.00	16.00	14@16	40.00	42.50
Denver, salmon	12.00	12.00	12.00	.....	.....
Dallas	11.10	11.10	11.60	35.00	.....
San Francisco	15.50	15.50	14.50	.....	.....
Los Angeles	11.50	11.50	13.00	(not used)	
Boston (del.)	17.50	17.50	21.00	45.00	50.00
Minneapolis (del.)	13.50	13.50	15.00	.....	.....
Kansas City	16.50	14.50	14.50	(no market)	
Seattle	15.00	15.00	14.50	.....	42.50
Cincinnati	17.00	17.00	17.00	40.00	45.00
Montreal	17.50	17.50	17.50	100.00†	68.00
Detroit (del.)	16.00	16.00	17.50	37.50	40.50
Baltimore	18.00	18.00	18.00	40.00	45.00
Atlanta	10.50	10.50	10.50	40.00	.....
New Orleans	15.00	15.00	15.00	.....	.....
Birmingham	12.50	12.50	12.50	40.00	45.00
Philadelphia	17@20	15@18	19.00	40.00	50.00
Pittsburgh (del.)	16.00	16.00	16.00	.....	.....
Cleveland	14.00	14.00	14@16	.....	.....

*For paving blocks 3x8½x4 and 3½x8½x4 respectively. †Imported.

HOLLOW TILE—Price per block in carload lots to contractor for hollow building tile.

	New York: Jan. 7 on Trucks*†	New York: One Year Ago	Chicago	Philadelphia	St. Louis	San Francisco†	Perth Amboy N. J., Factory*
4x12x12	$0.1112	$0.1162	$0.075	$0.12	$0.07	$0.108	.....
6x12x12	.1167	.1743	.096	.....	.095	.156	.....
8x12x12	.2084	.2179	.135	.22	.132	.244	.....
10x12x12	.....	.....	.167	.....	.165	.....	$0.252
12x12x12	.....	.....	.215	.....	.195	.....	.312

*5 per cent off for cash. †Partition tile.

	4x12x12	8x12x12	12x12x12
Boston	$0.085	$0.175	
Minneapolis (f.o.b. cars)	.0636	.106	$0.189
Minneapolis (delivered)	.07	.116	.205
Cincinnati	.07485	.13745	.....
Kansas City	.085	.145	.....
Denver	.075	.155	.188
Seattle (delivered)	.10	.20	.30
Los Angeles	.085	.172	.....
New Orleans	.13	.20	.....
Detroit (delivered)	.097	.165	.2821
Montreal	.12	.225	.30
Baltimore	.125	.27	.....
Atlanta	.0977	.1837	.....
Dallas	.10	.19	.275
Birmingham	.11	.1824	.215
Pittsburgh (delivered)	.068	.128	.179
Cleveland	.07	.149	.....

STRUCTURAL MATERIAL—Following are base prices f.o.b. mill, Pittsburgh and Birmingham, together with quotations per 100 lb. from warehouses at place named:

	Pittsburgh Mill	Birmingham	Warehouse: New York	Dallas	St. Louis	Chicago	San Francisco
Beams, 3 to 15 in.	$1.90@2.00	$2.05	$3.34	$4.15	$3.25	$3.10	$3.30
Channels, 3 to 15 in.	1.90@2.00	2.10	3.34	4.15	3.25	3.10	3.30
Angles, 3 to 16 in., ¼ in. thick	1.90@2.00	2.10	3.34	4.15	3.25	3.10	3.30
Tees, 3 in. and larger	1.90@2.00	2.10	3.34	4.15	3.35	3.10	3.30
Plates, ¼ in. thick and heavier	1.60@2.00	2.00	3.34	4.15	3.25	3.10	3.30

RIVETS—The following quotations are per 100 lb.:

STRUCTURAL

	Pittsburgh Mill	Warehouse: New York—Jan. 7	New York—One Yr. Ago	Chicago	St. Louis	San Francisco	Dallas
¾ in.	$2.60	$4.50	$4.25	$3.50	$3.65	$5.00	$4.75
CONE HEAD BOILER							
½ in.	2.90	$4.70	$4.35	$3.70	$4.20	$5.20	$5.00
⅝ and ¾	3.05	4.85	4.50	3.80	4.45	5.35	5.15
⅞ and 1	3.30	5.10	4.75	4.05	4.60	5.60	5.50

NAILS—The following quotations are per keg from warehouse:

	Pittsburgh Mill	Birmingham	Chicago	San Francisco	Dallas	St. Louis	Montreal
Wire	$2.65	$2.85	$3.15	$4.40	$4.55	$2.93	$4.95
Cut	2.80	2.90	.....	5.00	5.00	3.13	5.00

SHIP SPIKES—Current prices per 100 lb.:

In.	San Francisco: Galv.	San Francisco: Black	Seattle Black
½	$7.50	$5.75	$7.75
⅝	7.05	5.30	5.65
¾	6.90	5.15	5.50

Pittsburgh base in lots of 200 kegs or more, $3.25.

PREPARED ROOFINGS—Slate-surfaced roofing in rolls of 108 sq.ft. costs $2.35@$2.50 per roll to contractors in carload lots f.o.b. New York.

Single shingles, slate finish, cost $7.00 per square (sufficient to cover 100 sq.ft.) in carload lots, f.o.b. New York. Strip shingles (4 in. D f.o.b. New York, in carload lots to contractors, $5.00 per square.

ROOFING MATERIALS—Prices f.o.b. New York, to contractors in carload lots:

Tar felt (14 lb. per square of 100 sq.ft.) per ton	$70.00
Asphalt roofing (in barrels) per ton	25.00
Asphalt felt, per ton	72.00

WINDOW GLASS—United inches, 25, bracket size 6x8 to 10x15, single thickness "AA," 83 per cent; "A," 87 per cent; "B," 89 per cent. Double thickness "AA," 82 per cent; "A," 86 per cent; "B," 89 per cent discount from jobbers list at New York warehouses.

SHEETS—Quotations are per 100 lb. in various cities from warehouse also the base quotations from mill:

Blue Annealed	Pittsburgh Large Mill Lots	St. Louis	Chicago	San Francisco	New York
No. 10	2.50	$3.60	$3.50	$3.85	$3.89
No. 12	2.55	3.65	3.55	3.90	3.94
No. 14	2.60	3.70	3.60	3.95	3.99
No. 16	2.70	3.80	3.70	4.05	4.09
Black					
*Nos. 18 to 20	3.15	4.40	3.90	4.60	4.15
*Nos. 22 to 24	3.20	4.45	3.95	4.65	4.20
*Nos. 26 and 27	3.25	4.50	4.00	4.70	4.25
*No. 28	3.35	4.60	4.10	4.80	4.35
Galvanized					
No. 10	3.60	4.70	4.25	5.00	4.35
Nos. 12 to 14	3.70	4.80	4.35	5.10	4.45
No. 16	3.85	.....	4.50	5.25	4.60
Nos. 18 to 20	4.00	5.10	4.65	5.40	4.75
Nos. 22 to 24	4.15	5.25	4.80	5.55	4.90
*Nos. 26 and 27	4.30	5.40	4.95	5.70	5.05
*No. 28	4.60	5.70	5.25	6.00	5.35

* For painted corrugated sheets add 30c. per 1,000 lb. for 5 to 28 gage; 25c. for 19 to 24 gages; for galvanized corrugated sheets add 15c., all gages.

LINSEED OIL—These prices are per gallon:

	New York: Jan. 7	New York: One Year Ago	Chicago: Jan. 7	Chicago: One Year Ago
Raw in barrels (5 bbl. lots)	$0.93¾	$1.17	$1.00	$1.25

E. N.-R. Prices of Construction Materials

WHITE AND RED LEAD—Per 100-lb. keg, base price, f.o.b. New York:

	Dry		In Oil	
	Jan. 7	1 Yr. Ago	Jan. 7	1 Yr. Ago
Red	$15.25	$15.75	$16.75	$17.25
White	15.25	15.75	15.25	15.75

Lumber

Prices wholesale, per M. ft. b.m., to dealers in carload lots, f.o.b.

San Francisco—Prices of rough Douglas fir No. 1 common, in carload lots to dealers at yards. To contractors, $2 per M. ft. additional.

	6-8 and 12 Ft.	10-16-18 and 20 Ft.	22 and 24 Ft.	25 to 32 Ft.
3x3 and 4	$26 00	$27 00	$28 00	$31 00
3x6 and 8	26 00	27 00	28 00	31 00
4x4-6 and 8	26 00	27 00	28 00	31 00
3x10 and 12	26 00	27 00	28 00	31 00
3x14	30 00	30 00	32 00	34 00
4x10 and 12	26 00	27 00	28 00	31 00
4x14	30 00	30 00	32 00	34 00

	24 Ft. and Under	25 to 32 Ft.	33 to 40 Ft.
6x10	$28 00	$30 00	$32 00
6x14	34 00	36 00	38 00
8x10	28 00	30 00	32 00
8x14	34 00	36 00	38 00

New York and Chicago—Wholesale prices to dealers of long leaf yellow pine.

	New York		Chicago	
	20 Ft. and Under	22-24 Ft.	20 Ft. and Under	22-24 Ft.
3x4 to 8x8	$36.00	42.00	$42 00	$43.00
3x10 to 10x10	51.00	52.00	47 50	48 50
3x12 to 12x12	**58 00**	**53 00**	**57 50**	**58 50**
3x14 to 14x14	**66 00**	**67 00**	**66 50**	**67 50**
3x16 to 16x16	**73 00**	**74 00**	**75 50**	**76 50**

New York—Wholesale price to dealers; to contractors, delivered from lighters or cars to job, $5@$10 additional. Short leaf pine costs $3 per M. less.

Over 24 ft.—Add $1 for each additional 2 ft. in length up to 32 ft. for sizes 12x12 and under; for sizes over 12x12 add $2; for merchantable add $2 to sizes 10x10 and under.

Other Cities

	8x8-In. x 20 Ft. and Under				12x12-In. 20 Ft. and Under	
	P	Fir*	Hemlock	Spruce	P.	Fir*
Boston	**$51 00**	$48 00†	$51.00	$50 00	**$61 00**	$58.00†
Seattle		23 00				25.00
New Orleans	41 00				41 00	
Baltimore	32 50	49.25	53 00	60 00	38 00	49.75
Cincinnati	37 00	73 00	73 00	85 00	48 00	77 00
Montreal	50 00	58 00			60 00	65 00
Los Angeles		37 00				38.00
Denver		32 75	33.75	33.75		**49 50**
Minneapolis	42 00	**37 75**	35.00		44 50	**37 75**
Atlanta	31 00				34 00	
Dallas	52 25				56 00	
Kansas City, Mo.	44 50	40.75			59 50	41 75
Birmingham	32 00				34 00	
Philadelphia	56 00	34 00	37.00	**43 00**	65.00	34 00
Detroit	44 75	50 75			54.75	50.75
St. Louis	**41 25**				**53 25**	

	1-In. Rough, 10 In. and Under x 16 Ft.			2-In. T. and Gr. 10 In. x 16 Ft.	
	P	Fir*	Hemlock	P.	Fir*
Boston	**$46 00**	$42 00†	$45.00	**$51 00**	$48.00†
Seattle		20 00			22.00
New Orleans	80 00			40 00	
Baltimore	55 00	44 00	44 00	34 00	50 00
Cincinnati	70 00	79 00	75 00	38 00	85 00
Montreal	56 00	50 00	45 00	45 00	45 00
Los Angeles		37 00			
Denver		34 25	29.25		32.25
Minneapolis	42 50	**35 75**	34 75	38 00	**34 25**
Atlanta	**22 00**			28 00	
Dallas	**52 25**			56 00	
Kansas City, Mo.	42 25	37 75		43 75	36 75
Birmingham	20 00			**42 00**	
Philadelphia	34 00	33 00	36 00	52.00	34 00
Detroit	37 25	37 50		44 00	41.75
St. Louis	43 00			29.50	

Birmingham—Quotes carload lots, f.o.b. sidings; $4.00 additional per M. ft. to contractors.

Boston and Cincinnati—Prices to contractors in carload lots, f.o.b.

Denver—Quotes dealers price to contractors on large projects.

St. Louis—Wholesale price to contractors, f.o.b. cars, $2 per M.ft. additional.

Seattle—Price to contractors, delivered.

Dallas—Wholesale to contractors, $10 per M.ft. additional.

*Douglas fir. †Prime.

PILES—Prices per lineal foot, pine piles with bark on, f.o.b. New York.

Diameters	Points	Length	Barge	Rail
12 in. at butt	6 in.	30 to 50 ft.	$0.14½	$0.18½
12 in.—2 ft. from butt	6 in.	50 to 59 ft.	.19	.23½
12 in.—2 ft. from butt	6 in.	60 to 69 ft.	.21½	.25½
14 in.—2 ft. from butt	6 in.	50 to 69 ft.	.25½	.34
14 in.—2 ft. from butt	6 in.	70 to 79 ft.	.27½	.36½
14 in.—2 ft. from butt	5 in.	80 to 89 ft.	.35	.41

Miscellaneous

STEEL SHEETPILING—The following price is base per 100 lb. f.o.b. Pittsburgh, with a comparison of a month and a year ago:

Jan. 7	One Month Ago	One Year Ago
$2.30	$2.25@$2.30	$1.95@2.05

WIRE ROPE—Discounts from list price on regular grades of bright and galvanized are as follows:

	Eastern Territory New York and East of Missouri River
Plow steel round strand rope	35%
Special steel round strand rope	30%
Cast steel round strand rope	20%
Round strand iron and iron tiller	5%
Galvanized steel rigging and guy rope	7½%
Galvanized iron rigging and guy rope	+12½%

California, Oregon, Nevada and Washington: Discount 5 points less than discount for Eastern territory.

Wyoming, New Mexico and Colorado: Discount 5 points less than discount for Eastern territory.

Arizona: Discount 10 points less than discount for Eastern territory.

Montana, Idaho and Utah: Discount 10 points less than discount for Eastern territory.

North Dakota, Nebraska, Kansas, Oklahoma and Texas: Discount 5 points less than discount for Eastern territory.

MANILA ROPE—For rope smaller than ¾-in. the price is ½ to 2c. extra; while for quantities amounting to less than 600 ft., there is an extra charge of 1c. The number of feet per pound for the various sizes is as follows: ⅜-in., 8 ft.; ½-in., 6; ⅝-in., 4½; 1-in., 3½; 1¼-in., 2 ft. 10 in.; 1½-in., 2 ft. 4 in. Following is price per pound for ¼-in. and larger, in 1200-ft. coils:

Boston	$0.19@.25	New Orleans	$0.24½
New York	.27	Los Angeles	.24½
Chicago	.24½	Seattle	.24
Minneapolis	.26½	St. Louis	.24½
San Francisco	.24	Montreal	.16
Atlanta	.30	Detroit	.28
Denver	.25	Baltimore	.18
Cincinnati	.21	Kansas City	.21½
Dallas	.31	Birmingham	.30@.31
Philadelphia	.27		

EXPLOSIVES—Price per pound of dynamite in small lots:

	Gelatin 40%	Gelatin 60%
New York	$0.27	$0.295
Boston	.225	.25
Kansas City	.20@.25	.2225
Seattle	.165	.19
Chicago	.22	.245
Minneapolis	.1917	.2123
St. Louis	.22	.245
Denver	.2025	.2275
Dallas	.225	.302
Los Angeles	.1875	.2125
Atlanta	.215	.24
Baltimore	.22	.23
Cincinnati	.22	.245
Montreal	.195	.235
Birmingham	.23	.255
New Orleans	.233	.26
San Francisco	.1625	.1925
Philadelphia	.215	.24

CHEMICALS—Water and sewage treatment chemicals, spot shipments in carload lots, f.o.b. works:

Sulphate of aluminum, in bags, per 100 lb	$1.40@1.45
Sulphate of copper, in bbl., per 100 lb	4.50@4.60
Soda ash, 58%, in bags, per 100 lb	1.38@1.55
Chlorine, liquid, tanks, per lb	.04@.04½
Hypochlorite of lime (bleaching powder) in drums, per 100 lb	2.00@2.10

FREIGHT RATES—On finished steel products in the Pittsburgh district, including plates, structural shapes, merchant steel, bars, pipe fittings, plain and galvanized wire nails, rivets, spikes, bolts, flat sheets (except planished), chains, etc., the following freight rates are effective in cents per 100 lb., in carloads of 36,000 lb.:

Atlanta	$0.58	Detroit	$0.29
Baltimore	.31	Kansas City	.735
Birmingham	.58	New Orleans	.67
Boston	.365	New York	.34
Buffalo	.265	Pacific Coast (all rail)	1.15*
Chicago	.34	Philadelphia	.32
Cincinnati	.29	St. Louis	.43
Cleveland	.19	St. Paul	.60
Denver	1.15*		

* Minimum carload, 50,000 lb., structural steel only; 80,000 lb., for other iron or steel products.